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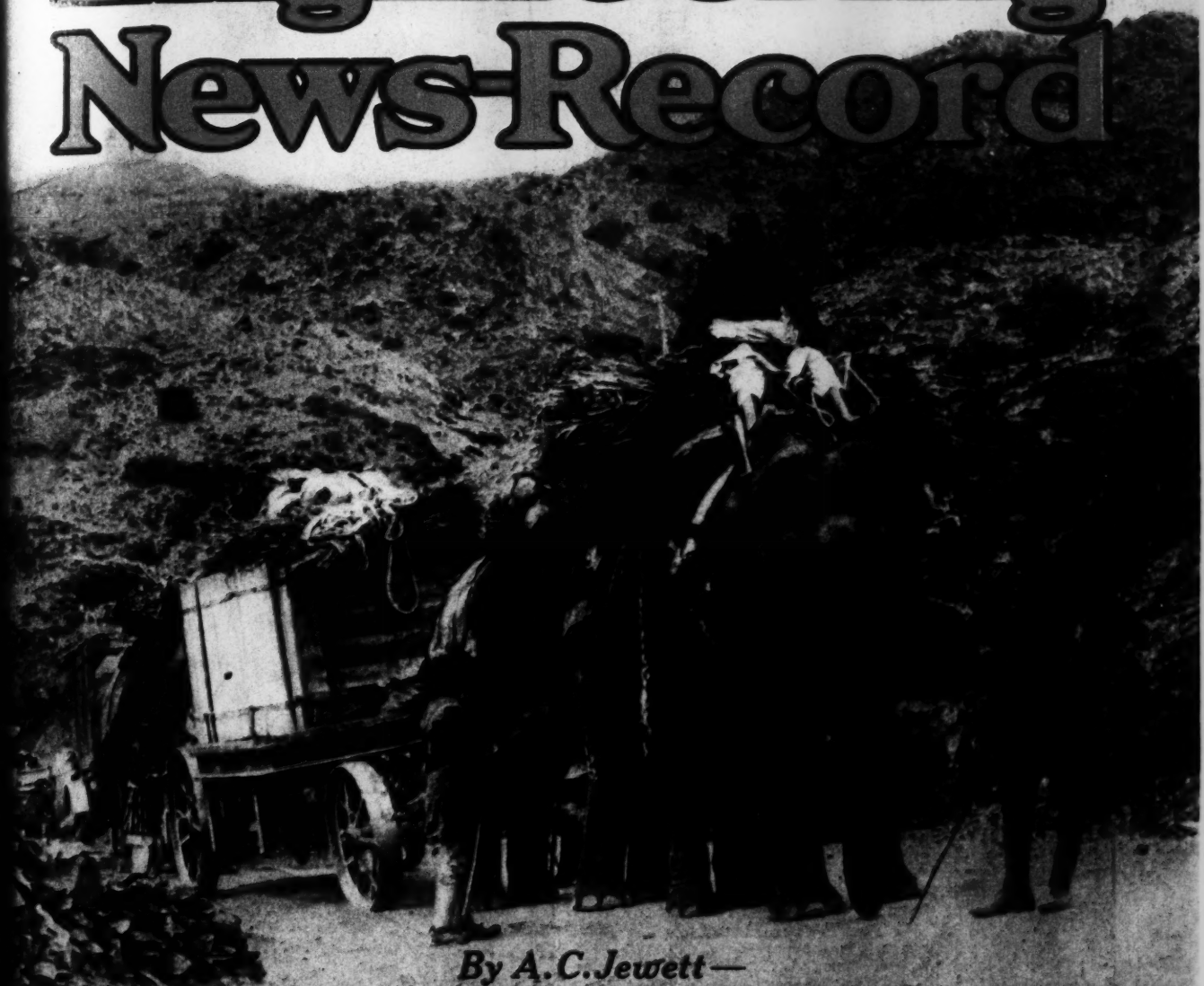

By A. C. Jewett—

Building a Hydroelectric Plant in Afganistan

Machinery Transported 250 Miles by Elephant Trains, Camels and Pack-Horses

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January 8, 1920

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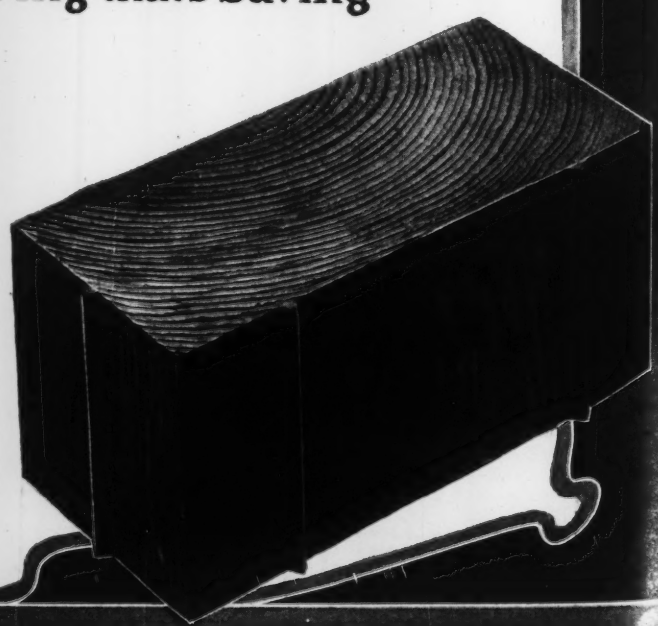

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN
Editor

Volume 84 — NEW YORK, THURSDAY, JANUARY 8, 1920 — Number 2

Machines Not Everything

MECHANICAL handling of freight at terminals is a manifest need of the future. Ship turnaround must be shortened and manual handling reduced, as one step in the decrease in the cost of goods delivered, which is only a part of the required increase in producing the world's needs. But there is danger in assuming that the adoption of machinery at terminals, just because it is machinery, without regard to its adaptability, will bring about the desired end. The fallacy of such a view is indicated by Mr. Nicholson in his article on the port of Seattle in our last issue. There are places, as he well points out, where a hand truck is by far the most economical machine of which a pier can boast, and it is by no means impossible that the much criticised cargo mast or ship tackle can in places handle many times as much freight as the most modern traveling crane or derrick. All of which only shows that designing terminal machinery is a highly technical matter calling for expert knowledge in each case. That knowledge can best be directed to the problem of the traffic as a whole, of getting the material moving without interference, and the machines or methods used to do this are special incidentals.

A Halt on Raising Prices

WE CANNOT commend too highly the view expressed in a letter in this issue by Howard W. Foote, president of the Northwestern Expanded Metal Co., setting forth that his organization has placed itself squarely on record as being opposed to further advances in the price of its product. Price advances sometimes are made with little thought of the possibility of instituting economies that will overcome increased wage and material costs. The easiest way is to pass the load along. The critical question is, "Can we get away with it?", meaning whether salesmen can dispose of the product at the advanced price. If the question be answered affirmatively, the advance is put into effect. To the credit of many large manufacturers, be it said that there has been serious consideration of the curtailment likely to follow in the wake of price advances, but all too often the manufacturer has sought no other justification than his ability to get the price. He has had preliminary justification in that his raw materials and his labor have gone up. Nevertheless, we are going to work out of this high-cost-of-living era at a fairly rapid rate only if all parties, the manufacturer and merchant, the worker and the public, are willing to make sacrifices. Mr. Foote shows that he wants to bear his part. A hotel in Chicago, taking the same stand, has decided not to advance its rates. In building materials, such an attitude is all the more desired right now, because with the shortage of construction materials there is going to be constant temptation to make increases.

A Symposium on Bridge Construction

WIDE circles will be affected by adopting the bridge specification that has been in preparation by a committee of the American Railway Engineering Association for several years past and is to come up for final consideration next March. Those who will be concerned in the result are certain to find even greater instructive value than will reside in the completed specifications, in an elaborate discussion of various specification clauses, just published by the association in its Bulletin 219. The discussion is made up of a series of criticisms and suggested alternative clauses, collected from prominent railway bridge men throughout the country, together with remarks in support of the specification clauses as drafted. Much of it relates to details of design and construction; other comments deal with loading, stresses, the relation between present and future safety, and similar factors of broad bearing on the subject. The views expressed contain as great a wealth of suggestion upon bridge design as has been offered to the structural profession for many years past. It is well worth note that the year of 1919, though, generally speaking, barren of prominent contributions to structural progress, has produced this compendium of expert opinion. Its influence will be felt, we believe, even beyond the life of the new specifications.

Port Construction Must Start Soon

FOREIGN trade has caught the imagination of the people of the United States. So far it cannot be said that much more than the imagination is involved, for the practical details are too remote to most business men to be grasped at once. This gap between hope and practice extends to port and harbor development, which must be one of the earliest steps in building up a foreign trade. Everywhere along the coasts, and in many places that are connected with the sea only by long and difficult waterways, there is public clamor for the development of the port to meet the demands of expected ocean business. And yet, with a few notable exceptions, actual construction is not going ahead. The Pacific coast, with its growing Oriental trade pressing upon it, is alive to the situation and is building now, but the Atlantic and Gulf ports, excepting Philadelphia and New Orleans, are doing more talking than anything else. New York, particularly, secure in its premier position, is in banderlog fashion telling of "the wonderful things we are going to do." On the Great Lakes, harbor construction is confined to the Federal Government's channel operations. In spite of this lethargy, the spirit of progress which undoubtedly animates the citizens of our port cities will soon have to be translated into actual works. Port authorities will be compelled before long to do more than make elaborate plans.

Machinery for Settling Industrial Disputes

THE MACHINERY proposed by the Industrial Conference for the settlement of industrial disputes, outlined in last week's issue, p. 49, is a step in the right direction. Our existing machinery of mediation and conciliation has proved inadequate. In fact, so little result has it had during the past year that the existence of mediation laws seems hardly to be known to the majority of our people.

Unlike its predecessor, the conference wisely refrained from discussion of the detailed relations that should obtain between employers and employees, realizing that no progress could be made in that direction. It is patent, of course, that the functioning of the proposed machinery will require sooner or later a definition of principles. But these will grow naturally as a body of practice and decisions and will, because of the regional makeup of the boards of inquiry and adjustment, have the backing of public opinion.

Basically, the merit of the plan proposed is that it will give all parties at issue, including the public, a clear view of the case. Disagreements are generally due to misunderstandings. When these are cleared conclusions are usually reached without the exercise of outside pressure. On the other hand, if the differences are fundamental—and more and more this happens in connection with widespread industrial disturbances—the mechanism of the boards of inquiry and adjustment will tend to separate the wheat from the chaff and concisely and clearly put the matter before the public—the court of last resort on such cases.

While the machinery proposed differs in detail from the conciliation and arbitration devices in use in other countries, in principle it is old. In a modern form, compulsory arbitration or inquiry runs back some twenty-five years—to the passage of the New Zealand compulsory arbitration act in 1894. It is now some seven or eight years since the last of the Australian states passed legislation with similar intent, though in two states the form takes that of compulsory wage boards rather than of compulsory arbitration proceedings. Canada passed its conciliation law in 1907.

As to one feature of the proposed measure, special comment is called for. There is no general prohibition of strikes, though when both parties have joined in the adjustment proceedings the existing status must be maintained. In so recommending, the Industrial Conference takes advantage of the experience of Australia and New Zealand. The best results seem to have come from a prohibition only of strikes without notice and of strikes while negotiations are under way.

The conference raises the questions as to the prohibition of strikes on essential public utilities. It does not settle the question, but says frankly that it shall have further consideration. In the end public opinion must prevail. As noted in the discussion of the Cummins bill in our last issue, there can be no denying the right of the community to forbid strikes in essential public-utility employment. It is not possible to tolerate suspension of work on the police, fire-protection and water-supply forces. It certainly is within the power of the community, too, to forbid strikes on railroads. Whether that is the wise procedure with a people saturated in the idea of liberty is open to question. Even recognizing the serious consequences to the community at large, it may be questioned whether it is not better to take some chance and to depend for solution upon an impartial inquiry, with a full setting of the salient facts before the public, forbidding, of course, suspension of work during the pendency of the negotiations. In other words, would it not be wise to extend to the railroads the same machinery for arbitration proposed by the Industrial Conference, with the added proviso that during the inquiry, whether the employees or the employers fail to participate, the suspension of work should not be permissible.

Everything considered, we believe that it would be well to put into effect the mechanism proposed. It would not be a panacea for industrial ills; the Industrial Conference realizes that fully. It would, however, give national sanction to a mechanism in each community for full inquiry into industrial difficulties. That national sanction would help to focus public attention and inspire confidence in the inquiry. There is little for either side to lose and much for themselves and for the public to be gained.

This Winter's Styles in Engineering Titles

MERE man, scanning the offerings of the shops in the daily press, is quickly reduced to a state of helplessness by the ever-changing nomenclature of things feminine. The good old days of silk and linen—straightforward, understandable terms—are no more. This is an age of specialization. To the lexicon of the department store fresh mysteries are added each day. Just when we pride ourselves in the knowledge that "georgette" is a filmy sort of material, and not the name of a French maid, we are staggered by reading of a sale of "duvetyn." But let us proceed no further. This is a dangerous field for masculine inquiry.

Nevertheless, there is apparent in the realm of engineering as in that of the emporium the same trend toward the new and the bizarre in the names of things. A generation ago it was the plain "civil engineer" who built the railroads, the bridges, the dams, the power plants and the other works by which the great sources of power in nature are directed for the use and convenience of man. In the tracks of this pioneer, however, followed a line of "specialists"—the "sanitary engineer," the "structural engineer," the "irrigation engineer," the "valuation engineer" and scores of others. Fresh impetus to the quest for distinctive titles was given by the advent of the "efficiency engineer" and it was not long before we had with us the "real estate engineer," the "industrial engineer," and even the "amusement engineer."

Until last week we felt sure that this winter's styles in engineer titles could offer nothing new. It has remained for the Consular Bureau in Washington, D. C., however, to dispel this illusion. The news dispatch on p. 106 of this issue heralds the discovery of an entirely new species of technical man—nothing else than the "retired engineer." Cloaked in the solemnity of official pronouncement, the call has gone out for "retired engineers," further referred to as "men with private means," to engage in consular work. Could the New Year bring a more welcome message? It is clear now that the rumblings of discontent in the national and local societies regarding inadequate pay and lowered status of the engineer in public esteem have little or no significance. Why have we been appointing these "committees on compensation" and

listening to reports of "development committees"? Away with them! The week's news from a bureau of a great department of our Federal Government assures us—by inference, at least—that engineers actually do "retire," just like bankers, head waiters, apartment-house owners and other men "of independent means."

The profession is indebted to the Consular Bureau for its reference to the winter's offering of "retired engineers" enjoying "independent means." The case of the engineer as viewed by official Washington, however, is much like that of the stranded actor who was asked whether he could change a $20 bill: "No," he replied, "but thanks for the compliment."

The Future of Our Waterways

NOTHING could be clearer than that our present Government policy in waterway development is a huge mistake. We are throwing away millions every year in improving channels for navigation where no navigation of consequence now exists or ever can exist. At the same time we are neglecting opportunities where, by concentrating expenditure, waterways could be opened which would yield returns proportionate to their cost. It is common to blame the individual Congressman for this waste of the taxpayer's money, for this scattering of public funds over all the Congressional districts, but the blame lies back of him. He does only what his district expects him to do. Added to the desire for personal or community gain which actuates many of the waterway enthusiasts, there is a vast body of public opinion which unreasoningly believes that inland water transportation is an economic necessity and that it is being kept from its rightful development by sinister influences.

This is a most curious manifestation of crowd spirit, unexplainable except, possibly, in terms of psychology. There is no sound justification for the average man's belief in inland waterways. He is swayed by a cumulation of suggestive influences, which have been catalogued by one writer as "the lingering glory of our waterways, the widespread movement for the conservation of all our natural resources, the relation of waterways to the reclamation of flooded lands, to the development of water power, and to sanitation, the supposed remarkable cheapness of water transportation, the opposition to the monopolistic tendencies of railways, the inadequacy of the railway service to meet the country's needs, the alleged benefits of waterways even to the railways, the avowed advocacy of waterway development by railroad men, and the extensive use of waterways in foreign countries."

Some of these influences, it will be seen, are intangible. Others are of so practical a nature that they may be scientifically investigated, but behind the bulk of waterway enthusiasm is no basis of solid fact. Offhand it is assumed that waterway transportation is desirable and that the only matter to be decided is the number of years over which to spread the expenditure. Enthusiasm should have its place, but not as the sole instigator of the expenditures of public money. There must be a solid foundation of fact. It is in the effort to establish the beginnings of such a foundation, at least, that the article on inland waterway transportation by Charles Whiting Baker, which began in the last issue, was initiated.

The first part of the article is a strong indictment of the pro-waterway argument as generally stated. It is shown, first, that the past need for the waterway in railway rate control probably no longer exists; second, that most of the ventures in water transportation in the past generation, even the most recent efforts under favorable surroundings, have been failures, and, third, that European experiences which are constantly cited as favorable to waterways are by no means as rosy as painted. A later part of the article is devoted to the study of relative unit costs of transportation by water and by rail. Here Mr. Baker contends that railway transportation costs have been steadily reduced, until they are now below the figure at which boats can operate. In a few locations, such as the Great Lakes, traffic is moved by water at rates below rail rates, but the number of places where this is possible is very small. Even there a large part of the apparently lower cost of water transport is due to the fact that channels are made and maintained year after year at the expense of the Government.

All of the deductions are not unfavorable, however, for in the last section of the article are outlined the possible advantages to be gained by certain specific waterways, on which it is suggested Government funds might well be concentrated. In the main these are in the vicinity of crowded centers where railway terminal charges are high or are extensions of routes where a waterway business is already profitably established. Just here Mr. Baker's argument might well be extended. If it is good economics to build new waterways where existing ones have proved waterway business to exist, it may be worth-while in the case of some existing but unprofitable waterways to spend considerable sums in order to get reluctant business.

The prospects of waterway transportation are involved in a vicious circle. Business cannot be procured until there are facilities in the way of terminals and regular and responsible service. Such facilities will not be provided until business is in sight. The only hope for success, then, is in investing a certain amount of Government funds in promotion to be written off as the development charge which must be part of the expense of every new business. The scientific analysis asked for by Mr. Baker would doubtless show in some of our lame waterways that it would be a legitimate gamble to put in some good money in the hope that it would not turn out to be thrown after bad. Just sitting down and hoping that business will automatically develop can only result in failure. There must be some ordered solicitation and encouragement of business from a public which, however enthusiastic it may be for waterways in the abstract, individually is more apt to send its freight by rail.

This is the only major exception we would take to the study as presented by Mr. Baker.

His study, as a whole, is a demand for a more scientific analysis of the waterway-transportation problem, and a plea for a relief from the mass opinion which shouts at conventions for waterways without knowing very well what it is shouting for. Engineers are better able than any other class to understand the huge waste resulting from our present waterways policy, and their united influence, at least, may well be exerted to bring about a reform in the general attitude toward waterways and a more detailed and appreciative study of the economics involved.

Building a Hydro-Electric Plant in Afghanistan

Machinery for 1500-Kilowatt Plant Had To Be Transported 250 Miles Through Khyber Pass by Pack Horses, Camels and Elephant Trains—Only Native Labor Available—Delays of Years in Waiting for Material

BY A. C. JEWETT
Engineer, Fresno, Cal.

PART OF THE FEED CANAL IN THE AFGHANISTAN HYDRO-ELECTRIC POWER PLANT

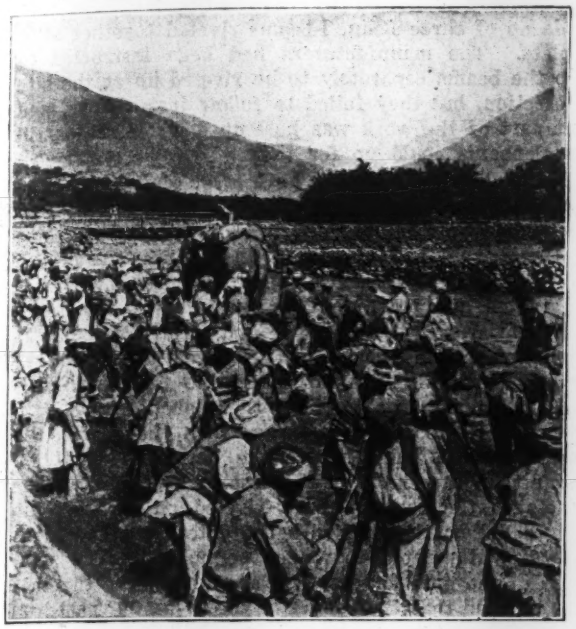
FROM early in 1911 until late in 1918 the writer was engaged in Afghanistan in the construction of a hydro-electric project for the ruler of that country. The work included building the dam and power canal, the assembling and erection of the machinery of the generating station, and the erection of the distributing machinery for a 1,500-kva. hydro-electric plant, in a remote part of a wild country far away from any modern means of transportation and with the aid of only one or two white men. The difficulties in such out-of-the-way engineering were so numerous, and the methods adopted so different from those in accepted use in a developed country, that the writer feels a record of it is worthwhile.

In 1910 the late Amir of Afghanistan bought from an English firm the machinery and material for a hydro-electric plant. The purchase price was Rupees 1,100,000, or $367,000, and the terms were full payment in advance f.o.b. Bombay. The amir was to arrange and pay for transport from Bombay into Afghanistan and for all erection of plant, the selling firm agreeing to recommend an engineer and two associates to make the installation. The services of the writer, to act as chief engineer in charge of the work for the amir, were obtained through the company which supplied the electrical machinery. At that time the writer had but recently returned from Kashmir to the States, having just completed the installation of a hydro-electric scheme for the Kashmir government. When the writer reached India in May, 1911, a large part of the amir's plant had arrived at rail-end in Peshawar, and most of the rest was on the way or in process of manufacture, so that there was no opportunity to make any of the changes in the layout that were afterward found to be necessary.

The power house was situated at Jabl-us-Siraj (the site of the old City of Parwan), 50 miles north of Kabul by road. The amir intended the plant to furnish power for operating the government machine shops, gun factory, mint, boot factory and woolen mills located in Kabul, and incidentally to light his palaces. No coal is mined in Afghanistan, and as the country is deforested, wood is very scarce and high in price. The present cost of operating the shops and mills by steam is over $150,000 per year.

The generating plant consists of three 500-kva., 60-cycle, 2,300-volt, three-phase horizontal General Electric alternators, direct-connected to Francis turbines designed to operate under a head of 130 ft. The transmission voltage of 44,000 is stepped up through type "H" oil-filled, self-cooling transformers, there being two banks of three 310-kva. single-phase transformers. The transmission line is 42 miles long, and consists of a single three-phase circuit, the wire being No. 2 B. & S. copper-clad steel. The wires are supported on pin-type insulators mounted on 50-ft. Milliken galvanized steel towers spaced 560 ft. apart. The tele-

POWER HOUSE BUILT BY AMERICAN ENGINEER WITH NATIVE LABOR AT JABL-US-SIRAJ, AFGHANISTAN



LABOR WORKS CHEAP AND IS NUMEROUS, AND ELEPHANTS ARE A NECESSITY

phone line consists of two No. 8 B. & S. copper-clad steel wires placed 6 ft. below the power wires. There is a substation in Kabul with transformers that step the line voltage down to 2,300, the distributing voltage. All of the induction motors but two are large enough to operate directly off the 2,300-volt circuit. The distribution lines are supported on Hamilton sectionalized steel poles, wooden poles being practically unobtainable.

The transportation of the plant from Bombay to railend at Poshawar (1,500 miles), and from there, by pack horses, camels, bull carts and on trolleys drawn by elephants, 250 miles to the site of erection, was time-taking, difficult and costly. The route lay through the Khyber Pass, via Jellalabad, thence through the mountains to Kabul and Jabl-us-Siraj. Loads would be taken part way in the autumn and dumped and left at some sari, because of the snow in the passes. Camels cannot be used in the hot months because of a fly that kills them off in the Jellalabad district. The heavy pieces were hauled on heavy trucks drawn by elephants, of which there were only nine available, and it took them three months and more to make a round trip. They could not be used in winter on account of the cold. The transport was all in charge of the amir and his officers, and the work was done by Afghans. The cost of transport, including the graft, was equal to the first cost of the plant. It was impossible to get accurate figures on it, but the amir told the writer that it was making the cost double to him.

The man sent to Afghanistan to locate the site of the hydraulic plant and make the plans and estimates was quite beyond his depth, and made many mistakes, some that were ridiculous and more that were serious. The canal was 1½ miles long, and he estimated that 100 men would finish it in 46 days. It was located on a side hill for about one-third of its length, and the hill had a slope of 1:1 and 1:1½. There were many big boulders that had to be blasted, and the whole hillside had to be shifted, a quarter of a million cubic yards of spoil moved, and all by hand labor. It took an average of 500 men three years to finish it. The gentleman that made the estimate was a conscientious man, but an intelligent rogue would have cost the Afghans less. He died of smallpox over four years ago.

The first lot of men sent out on this work were equipped with wooden shovels; moreover, they were weavers and did not know how to shovel. The power canal followed the site of an irrigation ditch, and as this was on a side hill with a steep slope and irrigation could not be interrupted, it was necessary first to enlarge another irrigation ditch, taken out further up the river, so it would carry for both the upper and lower systems, before work could be started on the power canal. This upper ditch ran alongside a rock cliff, and there was a lot of blasting to do. It took the sappers and miners that the amir sent most of the season to finish it. After it was enlarged work was begun on the power canal. The second year the amir supplied 500 sappers and miners for the work; it took him till

MATERIAL BEING HAULED 250 MILES OVER THE KHYBER PASS IN ELEPHANT CARTS

FIVE MOURNFUL AFGHANS CONSCRIPTED FOR WORK BY THE SOLDIER ON THE LEFT

May to collect them. They were supplied with tools and material for blasting. The sappers and miners (they called themselves "saffer miners" and we called them "suffering beggars") blasted out the largest boulders, and those up to a ton were hauled out with elephants. The elephants—there were two of them—were a great help; one elephant would handle more stone than fifty men.

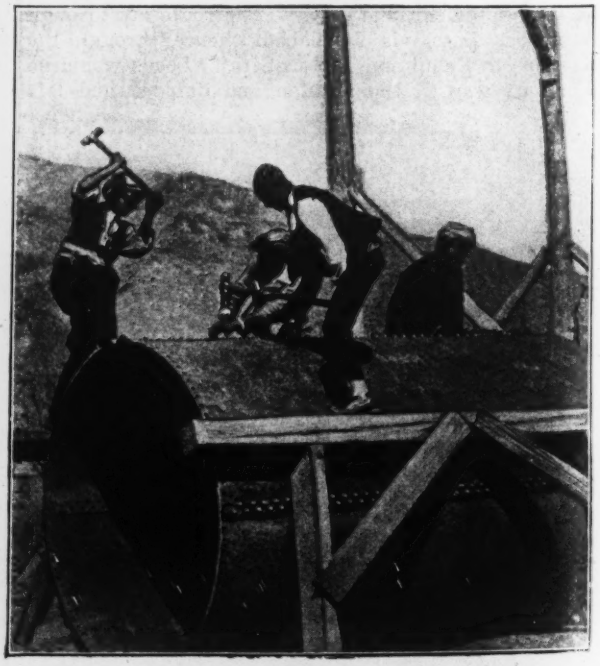
The river was a torrential stream. The building of the deflecting dam to turn the water into the canal was rather difficult, as there were no pumps, barring an old hand fire engine, nor was there any wood with which to build cofferdams or flumes. Cement delivered at the site cost $5 per cubic foot. The masons, *kalifa gil kars* (literally, "learned mud workers"), had never seen cement and had to be stood over with a stick to keep them from using it like mud. Most Afghan houses are built with sun-dried brick and mud, and it was difficult to get the "learned mud workers" to lay stone properly and be economical in the use of mortar. The labor was paid, but the pay was always months in arrears, and it was forced and unwilling. Masons got from 30 to 40c. a day and ordinary labor $1.60 per month. A man could get double that working for private parties. They ran away and were brought back and worked with leg-irons on. An Afghan dislikes anything that spells work, order or discipline; and most of them are past masters at shirking.

The power house had been located in a bend of the river bed in the dry season, and the river had to be turned to avoid its being flooded in the wet season. This took several months' work. The local bricks and lime were of very poor quality. Bricks left out in the rain melted down, the lime was slacked and full of stones and adulterated with earth. Condemned bricks and lime, sent away one day, came back the next. There was only thorny scrub with which to burn the bricks and lime, and it was not well burnt. The power house was of brick, and partly of some stone that had a good cleavage found in the Gurband Pass five miles away. It was impossible to use the lime mortar where it came in contact with water, for it melted like sugar, so the arch of the wheel pit was made with stone and cement and the walls of the pit were faced with stone laid in cement.

The work on the power house was held up nine months waiting for the girders that went on top of the central pilasters and supported the crane and roof. These were made up of three 12-in. I-beams riveted together with a plate. The manufacturers had been instructed to ship the beams separately to be riveted up at the site of erection, but they failed to follow instructions, and that part of the work was held up a whole season till the elephants could go for them.

The hydraulic apparatus gave a lot of trouble. The order for the turbines, which were made on the continent, had been sublet three times. The three turbine shafts were shipped in one case, and the case was broken up long before they reached rail-end, where they arrived red rusted and scarred. The shafts were condemned in Peshawar, and it was a year and eight months afterward before the replacements arrived at the power house. These were not turned true to gage (nor were the condemned ones); where there should have been press fits the bores were larger than the shafts, the worst instance being where the bore was 0.011 in. larger than the shaft, in the case of a coupling. The outlets to the receiver were riveted on crooked, the flanges did not line up with the gates, and had to be cut off and rotated to make the holes line up with those in the gate flanges. On assembling the turbines it was found that the flanges of the 27-in. 90° cast-iron elbows connecting to them were drilled wrong, and there was not enough stock in the flanges to permit drilling new holes. Over a year passed before these could be replaced.

The angles of the penstock had to be changed and 250 ft. of additional pipe ordered, making it 600 ft. long. The pipe was 6 ft. in diameter, with four plates to the circumference. The plates were shipped drilled and were fabricated at the site of erection. There were upward of 40,000 rivets hand-driven by natives. Not only had riveters to be trained, but most of the tools had to be made. The rivets were snapped in, and the old blacksmith got fairly expert making snaps out of old churn drills and crowbars. The biggest day's work

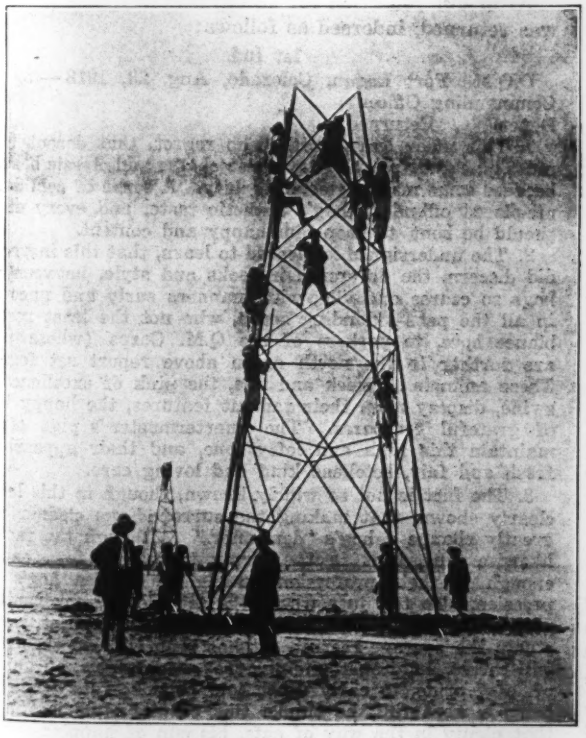


NATIVE LABOR RIVETING STEEL PENSTOCKS

was nine hundred §-in. rivets for one crew. Hammer men were changed every 20 min., and the average day's work was 300 rivets for one crew on longitudinal seams.

The transmission line had to be resurveyed and located. The iron for the steel towers was distributed by camels and elephants. It was first proposed to assemble the towers on the ground and raise them with a derrick in the usual way, using elephants instead of horses, but it was found to be safer and cheaper to build them up in position. The first few went a bit slowly until the men got used to the work. After a couple of weeks a crew of six men would erect two towers per day, at a labor cost of 48c. per tower. All the apparatus used was a light 20-ft. pole lashed to one corner angle, and two planks laid across the tower angles to stand on. The men got as expert as monkeys climbing about the towers, but not one of them knew whether a nut turned to the right or left to tighten without first trying it, nor did they ever learn. The wire was all tied in by Europeans; the natives could not be trusted to do it.

Labor was cheap, so cheap that it was very expensive. Skilled labor, native or European, was hard to get and hard to hold. Natives and Eurasians imported from India did not work out well under Afghan administration; they got the big-head and were hard to handle, as the amir would not discipline them as he did his own people. There are not many European workmen obtainable in the Far East that are useful on the construction work connected with a high-voltage plant. Of four men engaged in India, one took sick before crossing the border and another did not materialize. Of the two that came, one left inside of a year; he got a bad case of swelled head and struck for more pay, although he was getting more than he ever got before or probably ever will again. The other went on



AFGHANS SOON LEARN TO ERECT TRANSMISSION TOWERS IN PLACE

LOOKING ALONG ONE OF THE CANALS IN THE AFGHAN HYDRO-ELECTRIC PROJECT

leave to India and volunteered in the Army. Two assistants that were obtained from the United States were thoroughly good and competent men. One stayed out his contract time and left in 1914; the other died of typhoid pneumonia. Of two others that came from the States, one went down to India with the body of the man that died and decided not to return. The services of the other, who was not an American citizen, were dispensed with some two years ago; he turned out to be lazy and untrustworthy, and it was easier to do any work that he was supposed to do than to do it over after him or oversee him. Of three other men engaged to come from the States, one volunteered in the air service and the others were conscripted. The services of two others were lost owing to Oriental procrastination and war conditions. The work was always undermanned, with never more than four white men on the job, and that only for a short period.

Costs of imported material were high. As stated, cement delivered was $5 per cubic foot, wood only obtainable in pieces the size of ordinary railway sleepers, and all doors, windows and other woodwork for the buildings had to be made from these and worked up by hand. The overhead charges were enormous, owing to the high cost of labor supervision and the long time required to make the installation. The time alone spent on tinkering up and making over the hydraulic apparatus would have paid for and installed three new first-class turbines. The only men capable of doing this work were the white men getting from $4,400 to $4,800 a year. An efficiency expert would have gone mad before he had been on the job 48 hours. The Americans on the job used to mourn over the utter impossibility of ever conveying to anyone outside the country the difficulties that had to be contended with in making the installation. There were all the natural difficulties of the country, unskilled and unwilling labor, the long distance to haul and pack in material, faulty hydraulic apparatus, loss and damage in transport (much of it due to poor packing and failure of shippers to follow instructions given) plus Oriental procrastination and delays due to war conditions.

The power-house installation was finally completed and the turbines started on Feb. 5, 1917. Three hours later a door of one of the three main butterfly valve

gates failed, but quick work saved the plant from being flooded. On examination, both the doors in the other two gates were found to have failed and started to buckle. It was not possible to get new gates from England or Europe, and they were ordered to be made in Calcutta. Owing to war restrictions on manufacture and transport, it was a year and five months before the new gates were received.

Plant is Finally Put in Service

The plant was again started, and transformers were filled with oil and tested and made ready for operation last October. Just at this time G. R. Baker, who had arranged to take over and operate the plant, died, and the other assistant left. The writer had obtained leave from the amir to go home before Mr. Baker fell ill, but was detained by the amir for some time after his death. It was only after considerable delay that the permit for leaving the country was formally received and the writer left in December, 1918.

The amir was the most progressive monarch that Afghanistan has had. His greatest fault was laziness and procrastination, and it might be said of him that he reigned but did not rule. He took a personal interest in the electric scheme and made many plans regarding the good it was to accomplish and the savings it would make.

His majesty the amir was assassinated Feb. 20, 1919, near Jellalabad, where he had gone to escape the cold winter in Kabul. He intended his eldest son, Inayatulla Khan, to succeed him, but his brother Nasrulla overawed the son and seized the throne. A third son of the late amir, Aminulla, who was in Kabul at the time of the assassination, got control of the treasury, and the guns and ammunition, got the soldiers and some of the people to declare for him and announced that he was the new amir. His uncle submitted and went to Kabul, where he was thrown into prison by the son, Aminulla.

The papers have since reported that Nasrulla has been poisoned. The people became restive under the new amir, and it is supposed he began the present war with the British in order to hold them together. The country is in a chaotic state at present, the British air forces have blown up the powder works at Kabul and pretty thoroughly bombed Jellalabad and the surrounding district. The new amir has sued for peace.

The present situation is that there is a modern hydroelectric transmission scheme in the country all ready to operate (barring the assembling of a few motors in Kabul), there is not a European left in the country, and there are no Afghans or anyone else there capable of running the plant. The machines and switchboard at the power house were covered with old tents and left under a guard. Later, the country may quiet down and somebody carry on with the operation of the plant. But, *khuda madonad* ("God knows"), as the Afghans say.

Cement Content By Surface Area Method

In printing Fig. 3 in R. B. Young's article "Mixing Concrete by Surface Areas on Actual Work," in the issue of Jan. 1, 1920, p. 35, the decimal points in the figures for the abscissas did not register. Cement contents therefore seem to be recorded as 100, 200, 300, etc., when as shown by Table III on the same page they should be 1.00, 2.00, 3.06, etc.

Philosophic Reflections on Garbage-Fed Hogs in an Army Camp

WITH the lapse of a year since hostilities ceased there can surely be no harm in now making public an official report and "first indorsement" on the reaction to environment and treatment of two groups of hogs at one of our Army camps. The report reads:

Post Hospital, Fort Logan, Colorado.
Aug. 5, 1918.

From: D. A. Richardson, Contract Surgeon
To: The Surgeon
Subject: Sanitation Report

1. The company hog-pens located on the easterly sloping bank of the creek running west and south of this depot are of three groups, viz: a south, middle and north group.

2. The south group of seven pens and middle group of eight pens are unutterably filthy and in a most grossly unsanitary condition, both as regards the life of the hogs and as a menace to the welfare of the inhabitants of this depot and its immediate environment. The interior of these pens is covered with old bones and litter, and inside and immediately in front of each pig house proper are holes filled with urine and manure in which the hogs wallow. The hogs present a most unhappy appearance, and by their surliness of temper and fatigue demonstrate that they are troubled and harried not only by their environment, which is unnatural to porcine tastes, but also by the swarm of flies which are originating at this station.

3. The north group of six pens is quite clean and dry throughout, and the pigs demonstrate their contentment and satisfaction by activity, pleasant porcine demeanor and general cleanliness of body. There are no flies present in this north group of pens.

4. It is recommended that these pens be raked clean of bones and litter, the same be burned and not merely piled in heaps, and the interior of pens be properly graded and drained by ditches. This will guarantee a full financial return and benefit to this depot from the hogs themselves.

Daniel A. Richardson,
Sanitary Inspector.

After due reflection for 18 days, the foregoing report was returned, indorsed as follows:

1st Ind.

O.Q.M., Fort Logan, Colorado, Aug. 23, 1918 — to the Commanding Officer
Depot Returned.

1. This office learns with deep regret, that decent hogs must pine and fret, and lose their chaste and classic beauty, because some man neglects his duty. A sense of confidence misplaced offends a hog's æsthetic taste, and every effort should be bent, to keep him happy and content.

2. The undersigned is pleased to learn, that this inspector did discern, the difference in looks and style, between the hogs so coarse and vile, with manners surly and uncouth, in all the pens extending south, who not the least resemblance bore, to porkers of the Q.M. Corps (whose pens are farther to the north as in above report set forth). These animals so sleek and fine, the pink of excellence in swine, display upon their radiant features, the happy look of grateful creatures. The quartermaster's pigs alone, maintain this high and lofty tone, and their appearance fresh and fair, betokens kind and loving care.

3. The fact is not so widely known, though in this letter clearly shown, that making the surroundings cleaner will greatly change a hog's "demeanor." Although the fact is likewise true, that in the Army there are few, expert enough in their profession, to rightly read a hog's expression. To tell just where the trouble lies, by contemplation of his eyes, or by the wrinkles of his snoot, might stump the average recruit. It has been claimed that hogs will thrive, amid surroundings that would drive, an animal of lofty pride, to early death and suicide; that while his belly is kept full, he thinks this cleanly stuff is "bull"; that plenty in the way of eats, his cup of happiness completes.

4. As these opinions seem to vary, concerning what is necessary, to elevate the moral tone, within the hog's peculiar zone, it is most strongly recommended, that hogs in future be attended, by men expert in reading faces, who can at once detect the traces, upon the mournful physiog, of any poor disgruntled hog, that point to mental irritation or porcine trouble or vexation.

5. Psychology is thus combined, with physiognomy refined, and just a dash of the occult, might help the ultimate result. 'Tis thought the man in charge should be, a keen and competent M.D. Who but the medical department, could have of wisdom such assortment? Who but a graduate of college could have so vast a store of knowledge? The truth is we have no such store, of learning in the Q.M. Corps.

6. The main consensus of opinion, pertaining to the hog's dominion (which is perhaps not far amiss) appears to be about like this: Despite all scientific lore, a hog remains just as before; he makes a picturesque display, when viewed from far enough away; his grunt is musical and clear, providing you are not too near; he smells serenely sweet and clean, if proper distance intervene. But notwithstanding speculation, and philanthropic meditation, and theories of demagogues, most hogs will still remain—just hogs.

Z. N. STURMAN,
Captain, Quartermaster Corps.

Relation of Motor-Vehicle License To Highway Construction

An Address Given at the Louisville Meeting of the American Association of State Highway Officials, December 8-11, 1919

BY S. E. BRADT
Superintendent of Highways, State of Illinois

THE question propounded in the topic assigned to me is one calling for the judgment of each individual; and his answer will be governed to a certain extent by conditions existing in his own state. Therefore, what I shall say may not exactly apply to all states, but will serve, nevertheless, as a basis for discussion.

The providing of funds for governmental expenditure has been a problem in all ages. Every great emergency, such as the prosecution of war by a nation, and every great necessity, involving large expenditure and calling for largely increased taxation, has brought about new methods of providing funds. The underlying principle of taxation is that the taxes shall be levied as far as possible in proportion to the benefits received. Its practical application, however, involves levying the taxes upon those who have the money with which to pay. This is illustrated very forcibly by the revenue measures passed by Congress to meet war expenditures. Again, in levying taxes for highway improvement it must be done in a manner that will meet the approval of those who are to pay the taxes, for the reason that any extraordinary expenditure has to be approved by the people at the polls. The more nearly these three factors—(1) levying the taxes according to benefits received; (2) upon the people who have the money; (3) and with the approval of those who pay—can be merged into the plan of taxation, the more equitable and the more successful the plan will be.

We naturally come back to the oft-discussed question as to who receives the benefits from road improvement. That there is a general public benefit to our entire citizenship, applying equally to those who do not use the roads as well as to those who do, is beyond question. We are well aware of the fact that cheaper distribution by reason of good roads will mean cheaper farm products for all the people; that more readily accessible schools and churches and places of amusement will bring about a general betterment of society; that the free movement of fresh foods to the centers of population will bring better health to the communities; that better roads bring better farm conditions and more intelligent farming, which will mean increased production.

BENEFITS ACCRUE TO MOTOR-VEHICLE USERS

In addition to the general indirect benefits to all the people above referred to, there are direct and pecuniary benefits accruing to the users of the road. These, as you well know, arise from a saving of time to the car owner, a saving in wear of tires, a saving in repairs and in gasoline consumption, as well as from the added life of the car itself.

What these direct benefits to each car owner will average annually is a question over which there may be considerable difference of opinion. I think I am safe in saying, however, that there are very few people who will not place these benefits greatly in excess of the license fees charged at the present time by any of the states. So long as these fees do not exceed these direct benefits the tax is just and the motorist is not being harmed.

The motor license fees in Illinois averaged approximately $5 per car in 1917. In 1918 the fees were increased to an average of about $7 per car, and in 1919 the fees will average $10 per car. This fee will produce about $5,000,000 in 1920, which has already been appropriated as follows: For maintenance, $200,000, and the remainder to be expended on Federal-aid roads in connection with Federal money. This, however, is not all that is provided for road work in Illinois. During the same period there will be raised by general taxation through county and township levies about $15,000,000, or three times the amount received from motor license fees. In other words, the motorist, because of the direct benefits he receives, will be called upon to pay $5,000,000 because of these direct benefits. I do not believe this represents the correct ratio between the direct and indirect benefits of road improvement, and am of the opinion that there is considerable room for further increase in motor fees before we reach the right proportion. The above increases, however, serve to show the evolution in legislation and the change in public sentiment toward levying a larger tax on the motor vehicle.

MOTORIST WILLING TO PAY

Let us come back to the two practical factors in the problem of taxation mentioned above—namely, getting the money from the people who have it and getting it with their consent. The motorist not only *has* the small amount of money with which to pay his annual motor license fee, but *is willing*, even *anxious*, to approve any reasonable license fee that will bring about highway improvement. More than this, he is willing to pledge the payment of these fees over a long period of years as a basis for the payment of bond issues to be used for highway improvement. As evidence of this I would call attention to the fact that in Illinois the voters approved a $60,000,000 bond issue for highway improvement by a vote of 661,815 to 154,396; with the provision that the bonds and interest would be paid

entirely from the motor license fees, which required a 100% increase in those fees. Approximately one-third of the votors were motorists, and the most enthusiastic supporters of the proposition throughout the state were these motorists. I do not think that the people of Illinois differ very materially from the people of other states in their attitude toward questions of this kind. Therefore, what can be done in Illinois can be done anywhere.

For this reason I do not hesitate to say that if motorists can be assured that the money is to be expended properly they stand ready to give their approval to any reasonable, direct tax on motor vehicles for highway improvement.

I said in opening this discussion that a great public necessity which would require an unusually large expenditure often calls for a change in our method of taxation. Undoubtedly the license fees were inaugurated because of the excessive damage to the existing macadam roads by automobile traffic. The increased motor traffic made it apparent that these roads not only must be maintained, but that thousands of miles of additional roads must be surfaced. The amount of money required today to improve sufficient roads to meet the demands of public sentiment throughout the United States runs into billions of dollars. To add the amount thus required to the present heavy general taxation would undoubtedly result in failure in many of the states; but if the motorist is willing to assume a reasonable proportion of this cost through motor license fees, to go direct to road improvement or to the payment of bonds for road improvement, I believe the money can be provided as rapidly as the country can find labor, materials and transportation to carry on the work. The placing of a reasonable proportion of the cost of construction and maintenance of our highways upon the motorist is not only equitable, but will make the task of raising the money comparatively easy.

Disposition of License Fee Moneys

There has been much discussion over the question whether motor license fees should be used for construction, some people holding to the view that this fund was intended for maintenance only and should be confined to that single purpose. In Illinois a dollar looks just the same whether derived from general taxation or from motor license fees; and whether it be used for one purpose or the other, or both, is a matter to be determined by local conditions. Maintenance is absolutely essential, and if a state requires for maintenance of its roads the entire amount derived from motor license fees it is perfectly proper to devote it entirely to that end. If it requires only a part of the fees for maintenance, then why not devote the remainder to construction? Our policy should be to charge a reasonable fee somewhat in proportion to the direct benefit received and then use the money to the best advantage and where it will do the most good.

There is another phase of the problem of taxing motor vehicles; that is, that it will ultimately reach a very large percentage of the taxpaying population. Several of the states at the present time have an average of one vehicle to every 6 or 8 of the population. Illinois at the present time has one car to about every 12; but the present increase indicates that by 1923 we shall have one car to every 8. This means an average of nearly one car to a family. Therefore, while the motor license fee taxation will not be uniform as to the valuation of property, it will be fairly equivalent to a general taxation on the basis of the population.

Before closing, I wish to say that it is generally recognized that horsepower rating as a basis for motor license fees is not equitable. The man who drives his Ford car 1,000 miles in a year pays the same fee as the man who drives the same car 20,000 miles in the same length of time. The man driving the 1,000 miles should undoubtedly pay more in proportion to the mileage travel than the man driving the 20,000 miles. But his total annual tax should not be the same.

We are all waiting for some ingenious individual to work out a more equitable plan, such as a graduated gasoline tax by which each vehicle would pay a fee in proportion to its weight and the mileage driven; that is, in proportion to its actual use of the road.

In conclusion, the demand which we are now facing for highway improvement, calling for a volume of money never before dreamed of in any scheme of internal improvement, places us in a position where we shall be obliged not only to use the old-established methods of raising money, but to resort to any other equitable plan which may be devised. The raising of funds for this work by a license fee to be paid by the individual who uses these highways and receives a large direct benefit from this improvement is surely an equitable and proper source of revenue, and the benefit is so pronounced that the motorist stands ready to offer this assistance.

As has been indicated, the proportion which the motorist should pay toward highway improvement and maintenance will differ in almost every instance because of varying conditions. The proportion will to a large extent be determined by the license fees charged. If fees are based on benefits to the motorist, it is apparent that the greater the mileage improved or maintained, the greater the benefits—that is, the broader the scale of your plans the larger should be your license fees.

These matters, therefore, are for local determination in accordance with local conditions and local public sentiment.

Financial Results of Panama Canal Operation

The Panama Canal, in the year which ended June 30, 1919, earned $241,822 more than its operating expenses. The total cost of maintaining and operating the canal during the year was $6,112,194. Of this amount, $3,382,163 was for overhead charges for civil government, hospitals, quarantine, sanitation, etc. Tolls on the vessels passing through the canal amounted to $6,156,118, and revenue from licenses, taxes, fines, and profits on business operations increased this to total earnings of $6,354,016. The expenditures for maintenance and operation do not include any allowances for depreciation of the plant and equipment or any interest charges on the capital invested in the canal. The entire investment of the United States in the canal up to June 30, 1919, is $365,416,000. In addition to this, the operating expenses have exceeded the revenue to date by $4,618,690. The net earnings over operating expenses last year were about half what they were in the preceding year, the falling off being due to a decrease of about $58,000 in revenues and an increase of about $192,000 in operating expenses.

Record Forms for Activated-Sludge Plants, Houston, Texas

CAREFULLY detailed records are being kept of the operating results of the two activated-sludge sewage-works at Houston, Texas. There are reproduced herewith one of the daily report sheets, dealing chiefly with the power plant operations for supplying air; the headings of a monthly summary of daily reports of tank operations; and the key used for distributing operating expenses under six main accounts with a total of 59 subheads.

Analytical and other data are recorded on forms not here reproduced. Daily records are platted by months on ten diagrams combined on a single large sheet. These include: (1) Air pressure; (2) sewage flow in gallons per hour; (3) air discharge in cubic feet per hour; (4) percentage of sludge in tanks; (5) hours of aëration in tanks; (6) average relative stability; (7) per cent of reduction of suspended solids and (8) of oxygen consumed; (9) nitrogen as free ammonia, nitrite and nitrate; (10) machinery record, including hours of operation of the various blowers and of the sludge pump, and also the power consumed in kilowatt-hours, the fuel oil to drive the blowers at one plant and the water used.

KEY FOR DISTRIBUTING EXPENSES AT ACTUATED SLUDGE PLANTS, HOUSTON, TEXAS

Machinery:
- A1 Constant speed motor
- A2 Constant speed blower
- A3 Variable speed blower
- A4 Variable speed motor
- A5 Oil engine blower
- A6 Oil engine
- A7 Sludge pump
- A8 Sludge-pump motor
- A9 Air compressor engine
- A10 Air compressor
- A11 Supplies (miscellaneous)
- A12 Oil tanks
- A13 New equipment
- A14 Well pump and motor
- A15 Gasoline pump
- A16 Chain drive

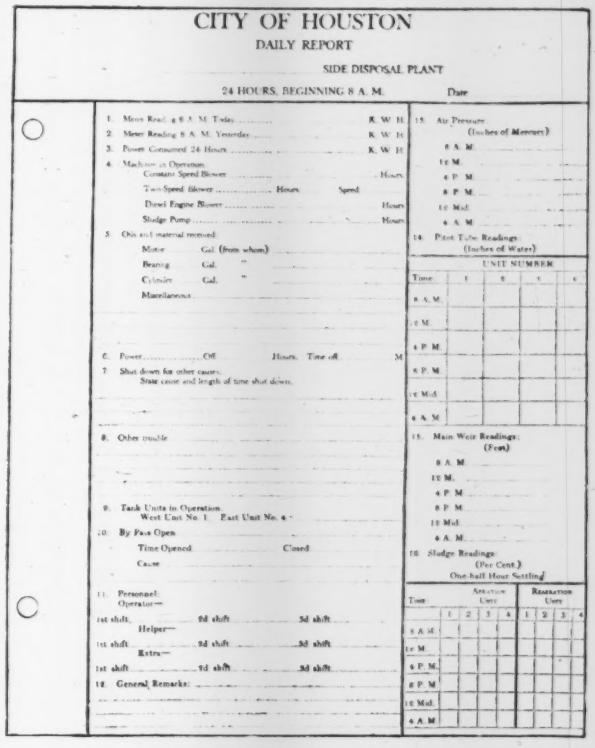
Building and Grounds:
- B1 Cleaning drain ditches
- B2 Maintenance slopes
- B3 Painting buildings, doors, etc.
- B4 Window and door glass
- B5 Roads
- B6 Supplies
- B7 Lighting
- B8 Heating
- B9 Railroad track
- B10 New equipment
- B11 Air screen sheeting

Concrete Tanks and Air Lines:
- C1 Repair concrete tanks
- C2 Repair C.-I. gates
- C3 Painting air pipe and valves and repairs
- C4 Filtros plate repairs
- C5 Filtros plate casting repairs
- C6 Water-pipe repairs
- C7 Supplies (miscellaneous)
- C8 New equipment (miscellaneous)
- C9 Cleaning tanks

Fuel, Power and Lubricating
- D1 Fuel oil
- D2 Cylinder oil
- D3 Bearing oil
- D4 Cup grease
- D5 Electric power
- D6 Water
- D7 Supplies
- D8 New equipment

Regular Pay Rolls:
- E1 Operators
- E2 Tank attendants
- E3 Supt. of sewers
- E4 Office
- E5 Chemist

Laboratory and Office:
- F1 Printing
- F2 Phone
- F3 Equipment
- F4 Chemicals
- F5 Sample bottles
- F6 Sludge settling tubes
- F7 Gasoline, oil, etc.
- F8 Gages, pilot tubes, etc.
- F9 Miscellaneous supplies
- F10 Experiments


CITY OF HOUSTON
DAILY REPORT
SIDE DISPOSAL PLANT
24 HOURS, BEGINNING 8 A. M. Date

DAILY REPORT SHEET FOR ACTIVATED-SLUDGE PLANTS, HOUSTON, TEXAS

The two works have rated daily capacities of 10,000,000 and 5,000,000 gal. each. Some notes on operating experiences at the works were printed in *Engineering News-Record*, Dec. 11-18, 1919. J. S. McVea is city engineer and G. L. Fugate is principal assistant engineer in charge of sewage disposal.

SUMMARY DAILY REPORTS OF.....SIDE DISPOSAL PLANTS
.....19.....

DATE	HOUR	SLUDGE IN TANKS				FLOW THRO PLANT			DETENTION PERIOD IN TANKS				AIR		
		SLUDGE % AER.	SLUDGE % RE-AER.	AVERAGE % AER.	AVERAGE % RE-AER.	FLOW PER HOUR	UNIT FLOW PER MIN.	VALUE P P'	TOTAL CYCLE IN MIN.	AER. %	RE-AER. %	AER TIME	RE-AER TIME	TOTAL CU.FT. PER HR.	PRES. IN INS. HG.
	4														
	8														
1	12 N														
	4														
	8														
	12 M														
	4														
	8														
2	12 N														
	4														
	8														
	12 M														
	4														

MONTHLY SUMMARY SHEET FOR ACTIVATED-SLUDGE PLANTS, HOUSTON, TEXAS

Channel Improvement Brings Marine Borers Inland

Teredos have just been discovered in piling in the outlet of the Sacramento River, 20 or 25 miles farther from San Francisco Bay than ever before. Attacks on piling in wharves at Port Costa led to a study of the matter, and Southern Pacific R.R. officials have expressed the opinion that the condition may be expected to continue permanently. In this connection, engineers of the railroad company point out that although there was no appreciable tidal effect at Sacramento 10 years ago, now there is a 1½-ft. water-level fluctuation there, corresponding to a 6½-ft. tide at San Francisco. Reasons which have been suggested for this are that as the Sacramento River channel has been straightened, deepened and diked, the tide waters have been able to sweep farther inland, and that as more water has been diverted for irrigation the degree of salinity in the lower reaches of the river has probably increased. While there have been instances recorded of marine borers in fresh water, it is thought that the presence of the teredo in the Sacramento River is due to the incoming salt water.

Unique Plant Concretes Seven-Span Arch Bridge

Bulk Cement Mechanically Handled — Concrete From Central Mixing Plant Hoisted Twice and Spouted Three Times — Radial Spacer Devised for Ring Steel

By Arthur Richards and Warren Carmichael
Bridge Engineer Engineer

CO-ORDINATION of equipment and correlation of operations have been developed with particular care in constructing the Broad St. bridge over the Scioto River at Columbus, Ohio. A central mixing plant, from which concrete is hauled in hopper cars by a locomotive to a traveling tower, places all concrete in a 679-ft. seven-span arch bridge by direct chuting. All operations are mechanical, from the unloading of the bulk cement cars and the gating of sand and gravel direct from stock piles, until the concrete is spouted into the forms. At no time in an active construction program has it been necessary to stop the mixer because any other plant unit has fallen behind schedule, and in concreting arches continuous runs of from 40 to 50 hours have been required.

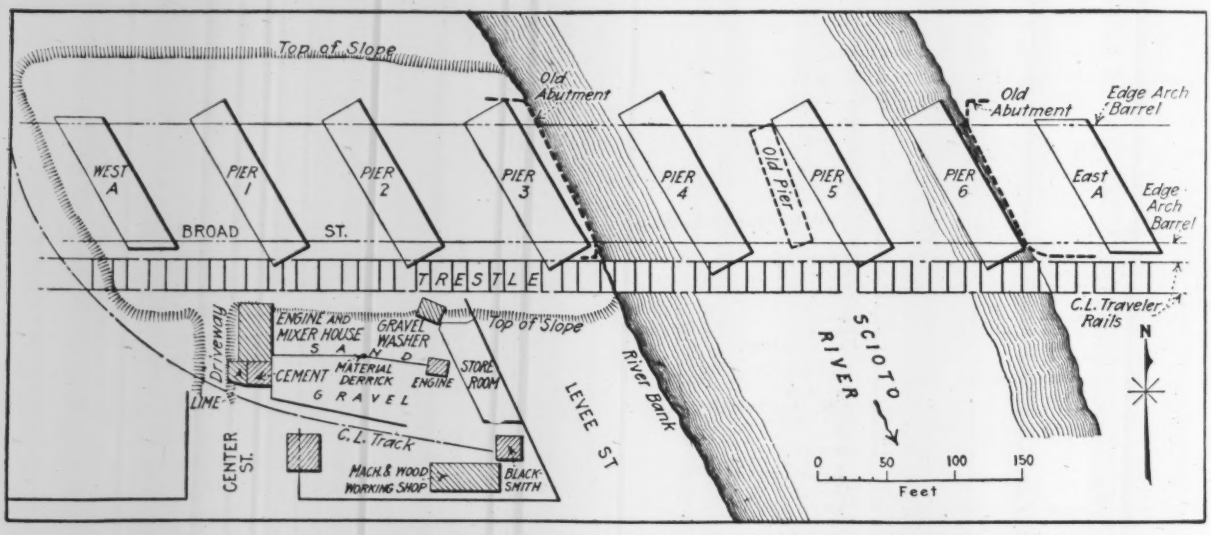


FIG. 1. PLANT LAYOUT FOR CONSTRUCTING BROAD STREET BRIDGE, COLUMBUS, OHIO

As shown by the plant layout plan, Fig. 1, the Broad St. bridge is on a skew of 30°. It is a part of the improvements involved in widening the Scioto River to reduce the flood danger to the City of Columbus, and it is a barrel-arch structure, with seven solid spandrel spans, two abutments and six piers. The length between faces of abutments is 679 ft. and the width over parapets is 87 ft. 8 in. The center span is 105 ft. and the spans on each side are 97 ft., 88 ft. and 78 ft. The foundations are in gravel overlying hardpan on bedrock, and consist of wide concrete footings in the gravel and without piles.

Substructure Construction

All foundations were constructed in steel sheet pile cofferdams, and in general involved methods commonly used; the methods being special to the conditions in a few details only. At the east abutment, due to distortion of the sheet piles by boulders, water in considerable volume came through the walls near the bottom and also up through the gravel bottom of the pit. The remedy for this was to build a form to the height of the footing slab about 6 in. inside the steel sheeting. Then on the gravel bottom 6 x 4 x 2-ft. stones from the old bridge abutment were placed so as to clear each other from 6 to 12 in. The concrete was poured on and between these stones, so that as the pouring proceeded the water was driven to the annular space between the form and the sneeting, whence it was removed by a 6-in. pump. Practically no wash of the concrete occurred. The abutment footings being on a slope, an effect of the use of the stones was the prevention of any flow of the wet concrete.

Under pier No. 4 there was a coarse, gray sand

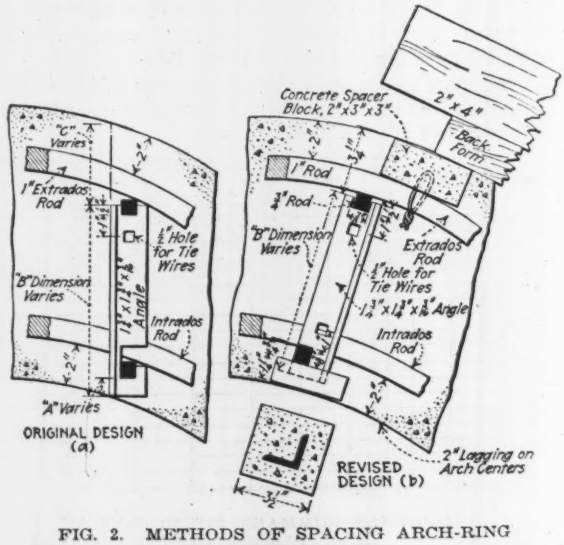


FIG. 2. METHODS OF SPACING ARCH-RING REINFORCEMENT

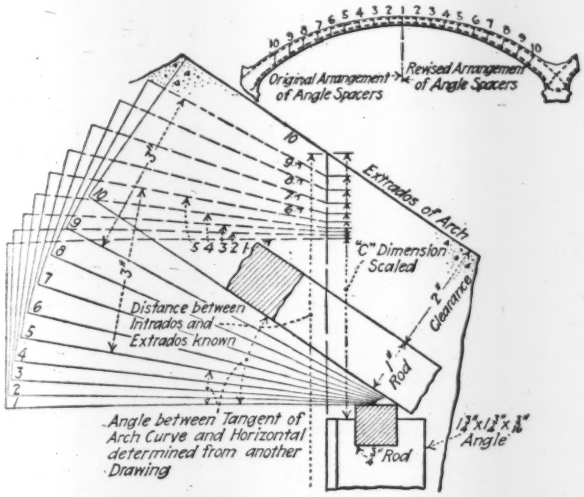


FIG. 3. GRAPHIC METHOD OF DETERMINING LENGTHS OF SPACERS

through which the water boiled in such quantity as to make it hazardous to lower the level below the sand, because of danger of a blowout under the sheeting. Here forms were built inside the sheeting, as was done at the east abutment, and a 2-ft. bed of concrete was deposited in water over the entire bottom inside the form. Most of the flow was in this way forced to the annular space between the form and the sheeting, and in the few cases where the larger boils continued to rise through the concrete they were left unchecked until stopped by the footing concrete. A test of the bearing power of this sand foundation was described in *Engineering News-Record* of July 31, 1919, p. 208.

Arch Construction

The arches are concreted as monoliths, the average volume of concrete being 1,200 cu-yd. for each. After the steel is in place on the center, the back forms are constructed up the arch, 6 ft. at a stage, using 2 x 16-ft. panels. Concrete is poured for two hours on one side, then operations are shifted to the other side for two hours. This procedure keeps the concrete green and gives the carpenters time to keep the back forms constructed ahead. At the crown of each arch, for about 25 ft., the concrete is placed without forms by the use of a mixture with less water.

Interesting experience has been developed in spacing reinforcement and holding the back forms in position. To maintain the proper distance between intrados and extrados reinforcement, angle spacers are used. The construction of these spacers for the first two arches is shown by Fig 2 (a). They are set 4 ft. apart along the arch and 6 ft. apart across the arch. Because of the curves of intrados and extrados, and because the spacers were set vertical, two dimensions *A* and *C*, not including the length *B* of the spacer, varied for each transverse set of spacers. Fig. 3 shows the graphical method adopted to determine these variables. In addition to the task of computing and checking *A* and *C*, this form of spacer proved objectionable from a construction viewpoint. The angle indents into the arch lagging and projects from the intrados when the centers are removed, involving either a rust spot or chipping and plastering. Also, because of the small bearing areas of the spacers nearer the haunches, excessive wiring is required to hold them in place, and this interferes with placing the concrete.

To remedy the difficulties experienced with the form of spacer shown by Fig. 2 (a), the arrangement shown by Fig. 2 (b) was devised. This design prevents the angle from touching the intrados forms; eliminates the two variables *A* and *C*, and, because of the radial position of the spacer, provides a firm bearing which necessitates only very little wiring. By wiring the concrete spacer block, as shown, to the extrados reinforcement, the back forms are held 2 in. from the steel without using struts which obstruct the concreting and when removed often permit the back forms to drop and squeeze out the green concrete.

Construction Plant

During the pouring of an arch the construction force consists of two crews which work 12-hour shifts, and the time to run an arch varies from 40 to 50 continuous hours. When the concrete plant is operating properly, which is most of the time, it averages about 33 cu.yd. per hour, the time being divided as follows: Sixty sec. in the drum; 20 sec. for dumping; 10 sec. return of drum; 20 sec. charging drum; or 110 sec. total time per batch of 1 cu.yd. The correlation of the various units which comprise the complete concrete-handling

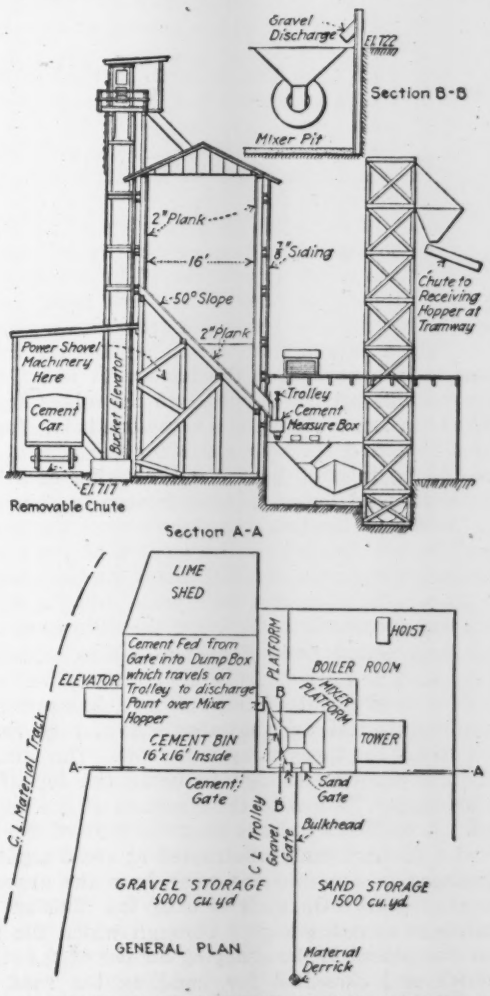


FIG. 4. DIAGRAM OF LAYOUT OF THE MIXING AND MATERIALS PLANTS

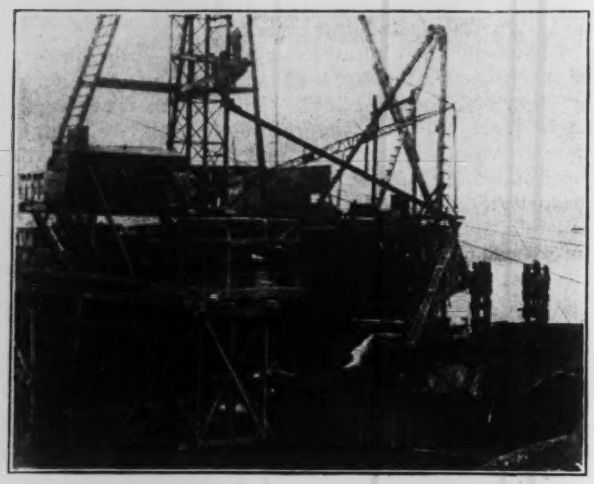


FIG. 5. CONCRETING A RIVER PIER

plant is excellent; at no time has it been necessary to stop the mixer on account of any of the other units falling behind the schedule.

Bulk Cement Mechanically Handled—Bulk cement is used, and the cement bin, Fig. 4, with its loading, storage and unloading features, has proved to be entirely satisfactory and economical in its operation. The bin has a capacity of 1,600 bbl., is 16 ft. square and 45 ft. high inside, and is constructed with a double wall to protect the cement from the weather. The floor has a 50° slope, the part near the discharge point being covered with sheet-iron plate to facilitate the movement of the cement.

The cement is unloaded from cars by an automatic electric car shovel, and is dumped directly into an elevator boot, from which it is conveyed by a bucket elevator to the top of the bin. It is taken from the bin through a vertical slice gate, and falls into a measuring box which is suspended from an I-beam trolley. The box is then pushed on the trolley for about 4 ft., and its contents are discharged into the mixer hopper. The box is in two sections, the lower one being for the hydrated lime and the upper one for the cement, the contents being released by the withdrawing of a horizontal sheet-metal gate which is located in the spout at the bottom of the box. In determining the size of the box, it was found that the volume of the cement as it came from the bin exceeded the theoretical volume, using the weight of cement as a basis, and the size of the box was increased to allow for the difference.

Aggregate Gated from Stock Pile—The method of handling sand and gravel from the storage piles to the mixer is somewhat out of the ordinary, has proved to be very economical and satisfactory, and is recommended where the topography will allow. The mixer is placed in a pit deep enough to bring the top of the charging hopper level with the elevation of the natural ground. A bulkhead is built near the edge of the hopper, and a division wall constructed at right angles to the bulkhead to separate the sand from the gravel in the storage yard. On each side of the division wall the bulkhead contains a gate through which the sand or gravel is passed to the charging hopper of the mixer. A derrick and clamshell for handling the sand and gravel takes these materials from the cars and dumps them on their respective sides of the division wall, and as the materials are being used in making concrete the derrick takes from the storage piles and dumps against the bulkheads, where the gates pass the materials to the mixer hopper.

This arrangement possesses an advantage over the overhead-bin type (1) in the cheaper construction cost and (2) in the fact that a breakdown in the material derrick cannot stop the concreting operations, as the material can be shoveled or moved in wheelbarrows to the gate openings.

Concrete Mechanically Distributed—One man controls the mixer, the aggregate-charging gates and the water. From the mixer the concrete is dumped into a bucket, is elevated by the plant tower and discharged into a chute which leads to a 2-yd. storage hopper, and from this hopper is discharged into two hopper cars which are hauled to the main tower which travels on the tramway.

The tramway extends along the entire site of the bridge and is located so as to clear the pier footings. It is constructed like an ordinary railroad trestle; carries a double-track narrow-gage railroad system over which operates a dinky engine and cars and which serves both as a medium for general hauling and for the transportation of mixed concrete; the tramway also carries the tracks for the traveling concrete tower. This tower consists of a 75-ft. quick-shift steel tower mounted in a wood frame, and is so constructed that the entire unit is stable when under load, requires no guying and may be moved on its own wheels by the dinky engine to any point on the tramway. The base of the tower is 36 ft. long, and the wheels operate on a 23-ft.-gage track. It is equipped with a steel boom and counterweight truss chute and has an effective operating radius of about 100 feet.

At the tower the concrete is discharged from the hopper cars into the tower bucket and is raised by an electric hoist to a tripping shoe which dumps the concrete into the final hopper, from which it flows through a gate into the final distribution chute. The truss chute can be raised or lowered so as to discharge the concrete mix from El. 700 to El. 740, and its flexibility

FIG. 6. ARCH-RING CONSTRUCTION IN PROGRESS

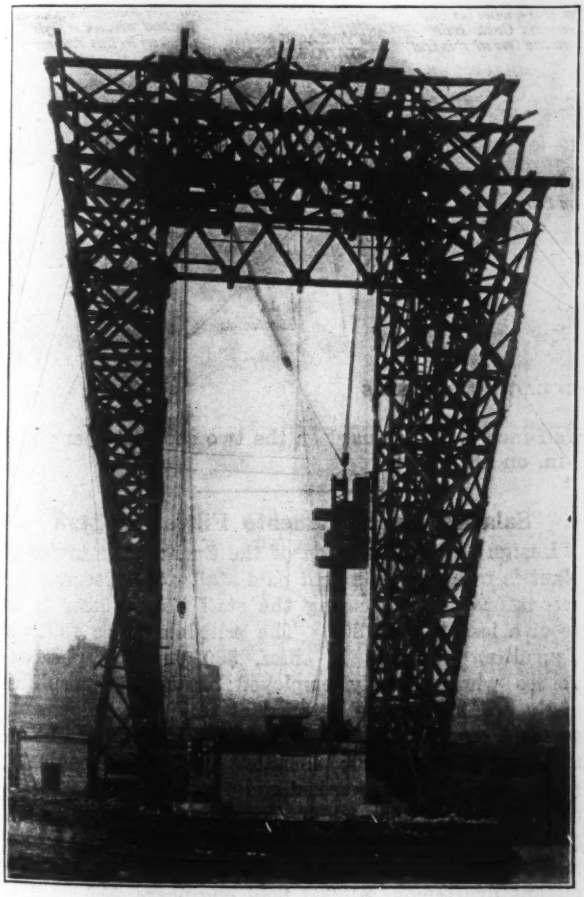
of vertical and horizontal motion allows for the placing of the concrete in all parts of the bridge structure without the expense of constructing costly additional chutes.

Gravel Mined on Job—As the material excavated from the piers consists of first-grade sand and gravel, a small plant was installed to crush, wash and screen the material, and inasmuch as the latest approved methods were incorporated in the plant, the sand and gravel produced has been exceptionally good.

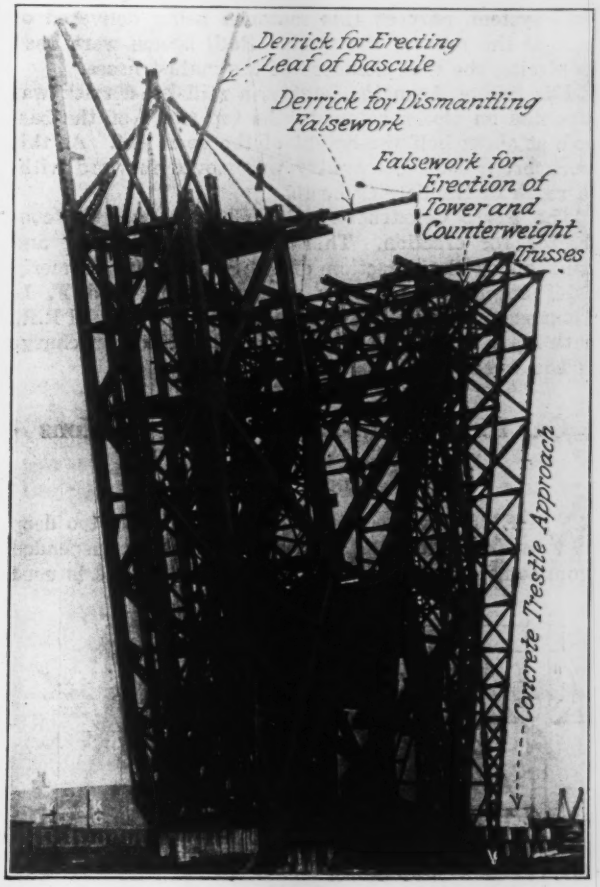
The bridge is being erected by the Carmichael-Cryder Co., of St. Louis, H. M. Cryder of the firm being directly in charge of the construction, with Charles Gove as superintendent and Warren Carmichael as engineer. It is being built for Franklin County, Ohio, under the supervision of the county engineer's office. Curtis C. Lattimer is the county engineer and Arthur Richards is the bridge engineer.

High Gantry Used for Handling Heavy Members of Large Bascule

A NEW departure in erecting bascule bridges was the use of timber falsework or a fixed gantry at the 260-ft. single-leaf double-track Strauss bascule bridge over the Chicago River for the St. Charles Air Line R.R., as shown in the accompanying views. This method was adopted by the contractor on account of the weights to be handled, the heaviest single pieces being the 70-ton rear sections of the bottom chords of the counterweight trusses with their trunnions.



GANTRY 168 FEET HIGH FOR ERECTION OF CHICAGO RIVER BASCULE BRIDGE


Derrick for Erecting Leaf of Bascule
Derrick for Dismantling Falsework
Falsework for Erection of Tower and Counterweight Trusses
Concrete Trestle Approach

BASCULE LEAF CARRIES DERRICK USED IN ITS ERECTION

This gantry consisted of four bents spaced 20 ft. on centers and carried on tracks 52 ft. apart at an elevation about 14 ft. below that of the railway tracks. Its extreme height was 168 ft. for the two rear bents and 118 ft. for the forward bent. Needle beams at right angles to the bents carried four sets of blocks and falls which were suspended approximately over the main and counterweight trunnions. The blocks were rigged in pairs on each side of the gantry, each pair being served by a hoisting engine located on the ground in the rear. The fixed tower, the counterweight trusses and links and that part of the moving leaf below the rear hip joint, were erected by means of the gantry.

In the erection of the remainder of the moving leaf a derrick was used, mounted upon it and shifted up as the work progressed, this being the more general method employed in building bridges of this kind. The derrick consisted of an A-frame traveling in timber guides bolted to the main trusses about midway between the chords and supported by timbers extending to the masonry below. The guides and supporting timbers were extended upward as the derrick was raised with the erection of the span. The forward boom handled the material for the floor system and bottom chord, which material was delivered on a barge. A rear boom handled material for the top chord and lat-

eral system, part of this material being delivered on cars at the rear of the work. Both booms were used in placing the web members of the main trusses.

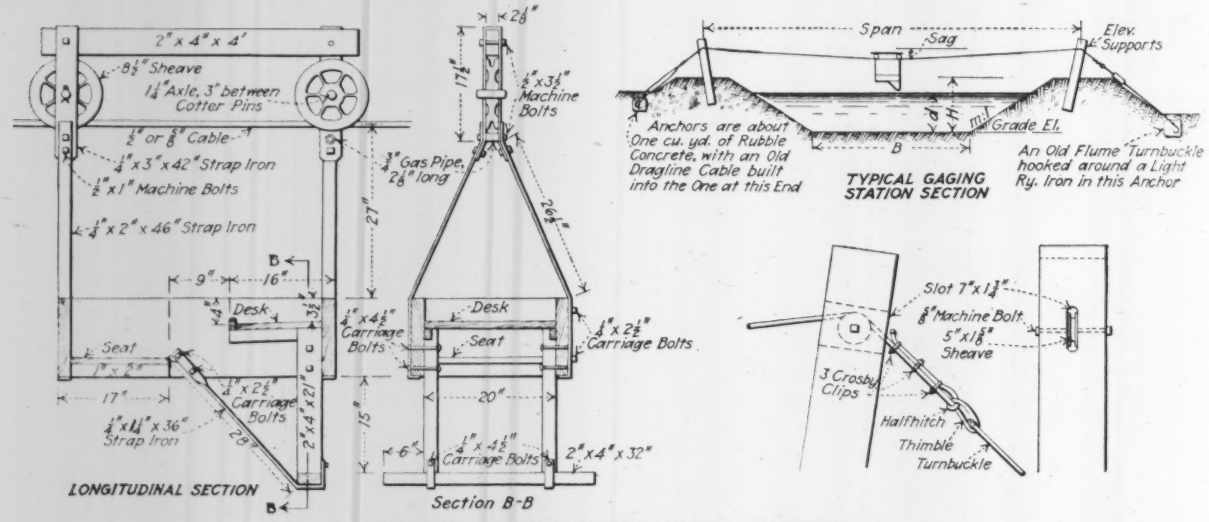
For taking down the gantry, a stiff-leg derrick was mounted on blocks bolted to the top chord of the bascule at about half the height of the open leaf. As this work progressed, the gantry was moved forward within reach of the derrick boom.

The Ferro Construction Co., Chicago, was the contractor for erection. This bridge was designed and built under the direction of A. S. Baldwin, formerly chief engineer (and now vice-president), and F. L. Thompson, present chief engineer, Illinois Central R.R., with Maro Johnson, assistant engineer, in direct charge of the work.

Car for Current-Meter Gaging Stations

By George Henry Ellis
Fairfield, Mont.

When using a current meter in a stream too deep to be waded, the instrument must be suspended from some support above the water. A bridge is used when convenient, sometimes a boat is used, and often a car is suspended from a cable stretched across the stream.


2" x 4" x 4'
8½" Sheave
¼" Axle, 3" between Cotter Pins
⅝" or ⅞" Cable
¼" x 3" x 42" Strap Iron
½" x 1" Machine Bolts
¼" x 2" x 46" Strap Iron
¾" Gas Pipe, 2'8" long
¼" x 3½" Machine Bolts
Desk
Seat
¼" x 4½" Carriage Bolts
¼" x 2½" Carriage Bolts
¼" x 1½" x 36" Strap Iron
2" x 4" x 21"
2" x 4" x 32"
LONGITUDINAL SECTION
Section B-B
Span
Sag
Elev. Supports
Anchors are about One cu. yd. of Rubble Concrete, with an Old Dragline Cable built into the One at this End
TYPICAL GAGING STATION SECTION
Grade El.
An Old Flume Turnbuckle hooked around a Light Ry. Iron in this Anchor
Slot 7" x 1¾"
⅝" Machine Bolt
5" x 1⅛" Sheave
3 Crosby Clips
Halfhitch
Thimble
Turnbuckle

CAR FOR CURRENT-METER GAGING STATIONS

The United States Geological Survey has developed a standard car for this purpose. It is designed to carry two men and is described in the bulletins of the Survey. The writer, when assigned to the measurement of water in the canals of an irrigation project, figured out a design for a one-man car. Two of these cars were installed on the Shoshone project of the United States Reclamation Service in 1911. When later assigned to similar work on another project, he looked up his old design and after a few improvements placed it on the accompanying drawing. Six of these cars were installed on the Sun River project in 1917, and two more in 1919.

In building these cars, the cables and iron work were practically the only new material used. Even the cement in the anchors had been charged to other work and left over. The nearest sand and gravel was used, whether clean or not, as no strength was required, only weight. The short cables in the left anchors had been discarded by the draglines which built the canal. Their long ends were wound among the plum rock to form part of the aggregate. The heavy 1¼-in. turnbuckles in the other anchor were salvaged from other work. The short pieces of light rail which these hooked around were probably superfluous, but they were scrap, and at least made good aggregate. A wornout plow point was used for one of these. The poles were short pieces cut from cull transmission-line poles. The lumber was all second-hand.

The gages for these permanent stations are 4 x 6-in. timbers set in the sloping bank of the canal at 90° with the center line. They were graduated with an engineer's level and marked with brass tacks. Zero of the gage was set at the theoretical bottom grade of the canal.

The elevations of the poles supporting the cables were determined from the bottom grade by adding the water depth, a small clearance—the height of the car, 4½ ft.—and the computed sag. To determine this sag readily a diagram was prepared from a formula by Mr. Stevens, published in *Engineering News* of May 6, 1909. Half-inch rope was used on the two shortest spans, and ⅝-in. on all others.

Salaries for Sacramento Filtration Staff

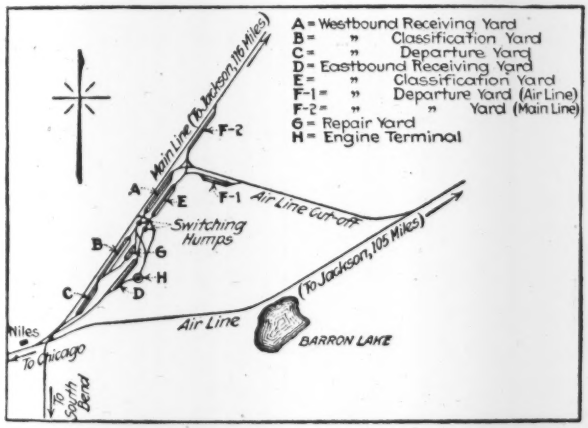
Design and construction of the Sacramento filtration plant is to be under a well paid staff of engineers. By recent ordinance creating the staff no engineer is to receive less than $1800. The schedule is as follows: Consulting engineer in chief, $50 per day plus expenses when actually employed; assistant consulting engineers, salaries to be fixed at time of employment; resident engineer, $6500; assistant hydraulic and filtration engineer, $5000; assistant structural engineer, $5000; assistant mechanical and electrical engineer, $5,000; office engineers, $3600; special assistant engineers, $3000; special chemist and bacteriologist, $15 per day and expenses; designers, $2700; draftsmen, $2400; assistant draftsman, $1800; field engineers, $3000; surveyors, $2700 junior field assistant, $1800, and engineering inspectors, $2400.

Gravity Freight Yard for Michigan Central Railroad

New Site for $4,000,000 Yard at Niles, Mich., Permits Free Design — Switching Humps Have No Scales — Engine and Car Facilities

NEW freight yards and engine terminals now being constructed by the Michigan Central R.R. at Niles, Mich., 93 miles from Chicago, will not only afford improved facilities for handling heavy traffic but will provide a change in operating conditions by the establishment of Niles as a new division point. The present division point is at Michigan City, Ind., 56 miles from Chicago, but the facilities here are old and inadequate and will be abandoned entirely. Thus the design and construction of the new facilities have not been hampered by any existing works on the site.

In the general design or layout a governing influence was the special condition imposed by the fact that Niles is a junction of two lines forming a loop between Jackson and Niles. This will be understood by reference to the accompanying sketch map. The "main line" or north side of the loop is 116 miles in length while the "air line" on the south is 105 miles. Through passenger service between Detroit and Chicago, 283 miles, is operated over the northern route, which serves a number of large cities; with these trains there is only one change of engines, this being at Kalamazoo, 142 miles from Detroit.



NEW FREIGHT YARDS, ENGINE TERMINAL AND CUT-OFF ON MICHIGAN CENTRAL R.R. AT NILES, MICH.

For freight trains, the line is operated in three divisions, engines being changed at Jackson, 74 miles, and at Michigan City, 153 miles by the "main line," and 142 miles by the "air line." When the new facilities are completed the change will be at Niles, 116 and 105 miles from Jackson by the two lines respectively. At present there are about 20 through freight trains eastbound and the same number westbound per 24 hours. Nearly all trains are broken up here for classification, only a few eastbound fast-freight trains being excepted. All traffic is general freight, with no preponderance of any particular commodity.

The special operating conditions which influenced the yard design, as noted above, may be explained briefly as follows: Through freight trains were handled mainly over the "air line" until the double tracking on the "main line" in 1905, since which time this has been used largely for westbound through freight, leaving the single track "air line" for eastbound through freight. This latter is the heavier movement and is operated in standard full-load trains of about 3000 tons or 90 cars. When double-tracking is extended over this line it is probable that practically all through freight trains will be handled over the "air line." No facilities for cattle, for icing refrigerator cars or for transferring and consolidating less-than-carload freight are required at this point.

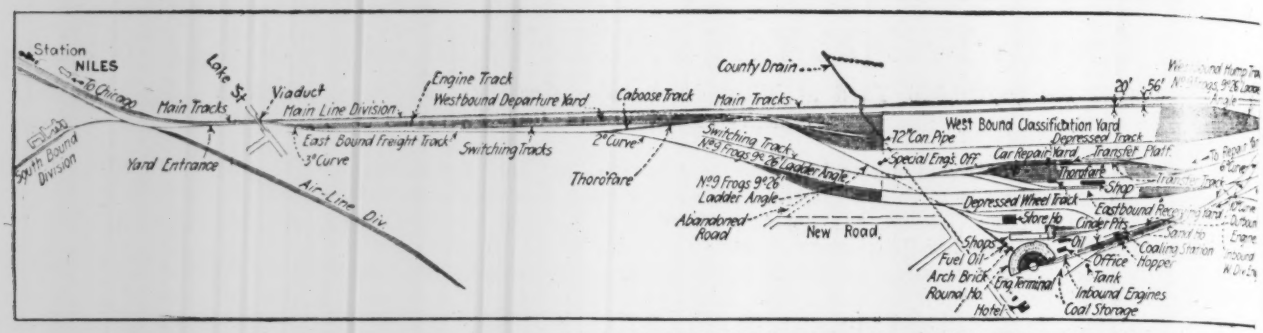
For the entire line between Chicago and Detroit, the established ruling grade is 20 ft. per mile eastbound and 25 ft. per mile westbound, although a few steeper grades still exist. On the main line there is only about a mile of 20-ft., maximum grade, this beginning near the station at Niles. On the "air line," however, there is about a 3-mile grade of 40-ft. per mile, extending from Niles to Barron Lake, so that eastbound through freight trains required the use of pusher engines for this distance. To avoid this long and relatively heavy grade against standard trains a four-mile cut-off is being built, connecting with the main line about four miles east of Niles, as shown on the sketch map. When this is completed the old line may be used only for switching purposes and for access to the ice houses at Barron Lake.

General Layout of Yard

The new yards and other facilities are located parallel with and on the east side of the main line from Niles to the junction of the "air line" cut-off. They will comprise westbound receiving, classification and departure yards arranged in tandem. The eastbound receiving and classification yards also will be in tandem, but followed by two separate departure yards on the main line and air line respectively. Classification will be done by gravity switching over two humps. In addition, there will be a car repair yard and an engine terminal with repair shops. The total length between end switches is 4.73 miles and the site has an area of about 560 acres.

It was intended at first to provide simply a modern substitute for the present obsolete facilities at Michigan City. In view of the heavy and increasing traffic, however, it was decided that real economy would be secured by designing such a yard as would meet the requirements of the near future and then building a sufficient part of this to take care of present conditions. The plan on the next two pages shows the complete layout, with certain temporary connections necessary for the operation of the first unit, particulars of which are outlined further.

For westbound traffic, the arrangements are as follows: Inbound trains enter a receiving yard having eight tracks, with space reserved for eight more. From this the trains will be passed over the hump and the cars switched by gravity into a classification yard having 28 tracks, with space reserved for 14 additional tracks. Beyond this is the departure yard, with four tracks, in which outbound trains will be made up ready for the road engines. For eastbound trains, the receiving yard will have eight tracks, with space for double the number; the classification yard will have 24 tracks



PLAN OF FREIGHT YARDS AND ENGINE TERMINAL FOR NEW

and space for 34, while the two departure yards will have two and three tracks for the main line and air line divisions respectively. Departure tracks will not be equipped with air pipes for testing brakes.

Track and Switching Humps

The length of yard tracks will be about 4200 ft. for receiving and departure yards, while 4000 ft. is the minimum for classification yards. As the overall length of cars averages about 42 ft. this gives each track a capacity of at least 100 cars, which is the maximum train length, the average being about 90 cars. Body tracks in the yards have the arrangement of an alternate spacing of 13 and 15 ft., instead of a uniform spacing, to afford wider spaces for car inspectors and car checkers, besides providing for temporary piling of snow and track material. The spacing from main tracks and running tracks to the nearest yard track is 20 ft. on centers.

Ladder tracks will have an angle of 9°, 26′ and will be equipped with 15-ft. switch rails and No. 9 frogs. By using the Torrey system of switch layouts, with a lead of 72.43 ft. for such frogs, this arrangement gives a distance of 13 ft. between the point of frog and the next headlock or switchpoint, as shown in the detail drawing. No curve sharper than 7½° is allowed for full train movements and no curve in the entire yard system will exceed 10°. All tracks will be laid with 80-lb. rails. Slag ballast will be used for main tracks and gravel for yard tracks.

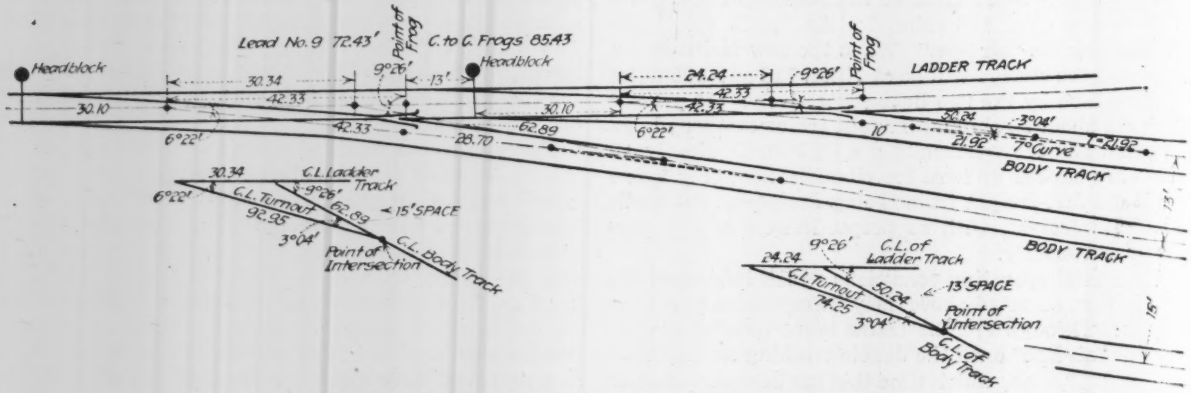
Hand operation of switches will be used for the classification yards. Car riders will be returned from these yards to the humps by gasoline motor cars or steam locomotives. For night work, electric "flood" lights will be placed on the hump, at the east end of the westbound receiving yard and at the west end of the classification yard. There will be several lights at each location, so that beams may be cast through the length of the several yards. They will be mounted on masts about 65 ft. high.

Profiles and grades of the switching humps will conform to the recommendations of the American Railway Engineering Association, except that operating conditions with the first unit and its hump will require lower elevation and flatter grades, as noted below. The accompanying table gives the profiles for the humps in this yard and in the new Markham yard of the Illinois Central R.R. at Chicago, as described in *Engineering News-Record* of Aug. 5, 1918, p. 313.

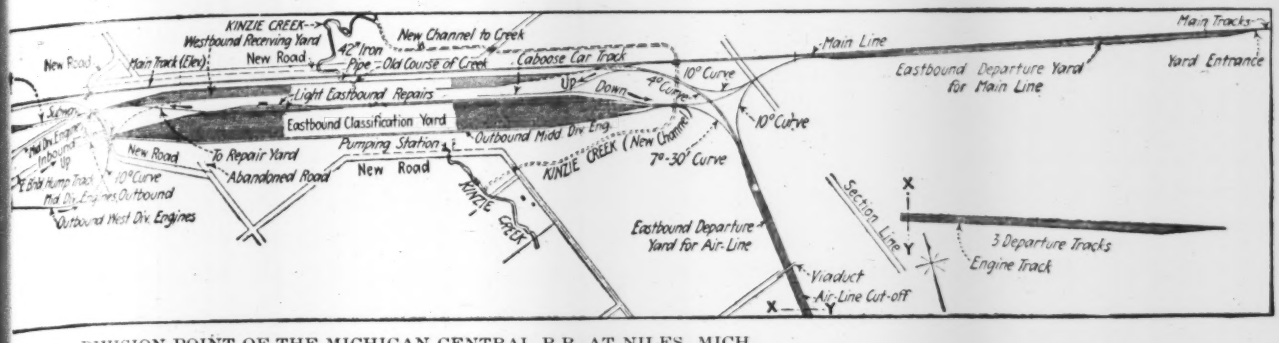
Vertical curves for changes in grade on the humps have been made as easy as practicable, with lengths usually not less than 50 ft. Where a longer run is available and entails no great additional expense these curves are made several hundred feet in length, as at the ends of the yards away from the hump and on the

PROFILES OF HUMPS FOR GRAVITY SWITCHING

Michigan Central R.R.		Illinois Central R.R.	
Niles Temporary	Niles Permanent	Markham Northbound	Markham Southbound
Approach Side: Up Grades			
From 0.2%	2800 ft. of 1%	1900 ft. level	2700 ft. of 1%
400 ft. of v. curve	60 ft. of v. curve	150 ft. of v. curve	150 ft. of v. curve
100 ft. of 0.5%	up to rate of 1.67%	300 ft. of 2%	1100 ft. of 2%
200 ft. of v. curve	.....	150 ft. of v. curve	150 ft. of v. curve
450 ft. of 1%	.....	.....	.....
80 ft. of v. curve	.....	.....	.....
440 ft. of 2.5%	.....	.....	.....
Summit			
100 ft. of v. curve	60 ft. of v. curve of 1600 ft. radius	75 ft. level*	75 ft. level*
Gravity Side: Down Grades			
.....	.....	150 ft. of v. curve	150 ft. of v. curve
30 ft. of 4%	60 ft. of 2%	150 ft. of 3%	400 ft. of 3.5%
100 ft. of v. curve	40 ft. of v.c., 2000 ft. rad.	150 ft. of v. curve	150 ft. of v. curve
150 ft. of 2%	50 ft. of 4%	400 ft. of 4%	450 ft. of 1.5%
250 ft. of v. curve	150 ft. of v. curve	150 ft. of v. curve	150 ft. of v. curve
Through Ladders and Yards: Down Grades			
3000 ft. of 0.5%	1300 ft. of 1%	1000 ft. of 1%	800 ft. of 0.75%
.....	2100 ft. of 0.5%	.....	.....



TYPICAL LAYOUT OF LADDER TRACKS AND SWITCHES



DIVISION POINT OF THE MICHIGAN CENTRAL R.R. AT NILES, MICH.

main track of the new cut-off line. All vertical curves are figured as parabolas. No track scales will be placed on the humps as there is little weighing to be done at this point. Cars needing to be weighed will be passed over the hump to a track from which they will be taken to the yard scale later.

Caboose cars of trains coming in at the west end will be switched onto a single track connecting with the ladder of the rear end of the departure yard. At the east end, these cars will be switched on an ascending grade to a stub track, from which they can be passed down the same grade to trains on either of the two departure yards.

Engine Terminal and Car Repairs

A car repair yard located between the westbound classification and eastbound receiving yards will have eight tracks of 1400 to 1900 ft. clear length. These will be spaced alternately 20 ft. and 22 ft. on centers with a standard gage track in each 22-ft. space for a lorry or material car. Other facilities of this yard will include a material supply track and a depressed track for loading and unloading wheels. One track alongside a transfer platform will serve for shifting freight from damaged cars that cannot be forwarded without heavy repairs, the freight being reloaded into other cars on the same track. A depressed transfer track will facilitate the shifting of bulk freight directly from crippled cars into other cars.

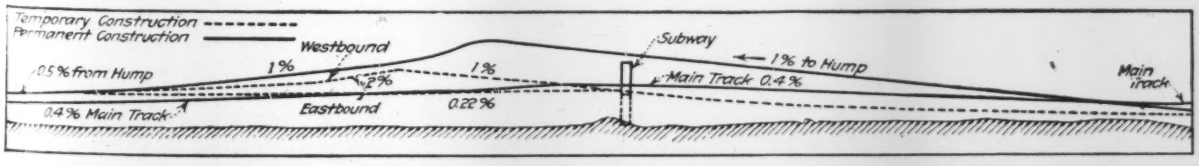
Cripple tracks from the westbound hump will enable cars to be switched directly to the repair yard instead of moving to the classification yard. In eastbound trains, the crippled cars will pass over the hump to a set of three repair tracks on the west side of the classification yard for light repair work and for the repair of cars of fast-freight lines. Eastbound cars needing heavier repairs will be held until a track is full and the train of cars then switched across to the westbound tracks and moved back to the main repair yard. Car repair tracks will be equipped with compressed air piping for the operation of pneumatic tools and for testing brakes.

An engine terminal located at the south end of the layout and east of all yard tracks will have facilities for handling, cleaning and coaling 60 engines daily, including the hump engines and yard switching engines, which latter will be few in number. Engines of eastbound trains can move directly from the receiving yard onto a lead track and then back directly onto this terminal, while from it they can go directly to the two eastbound departure yards. Special arrangements are required, however, for connection with the westbound yards. A track from the receiving yard passes under the humps and so enables inbound engines to reach the terminal without interference with switching movements. A semi-circular loop track of 10 deg. also passes under the humps and gives outgoing westbound engines access to the departure yard without interfering with eastbound trains pulling up the 20-ft. grade into the receiving yard. Inbound engines from the west, instead of going to the roundhouse, can take coal and water and pass directly over this loop to the departure yard and take outbound trains for the west if necessary.

A reinforced-concrete roundhouse 100 ft. deep will have stalls for 30 engines and a through approach track at the west side for emergency service. Space is provided for extending this building to provide 56 stalls and five approach tracks. An electrically operated 100-ft. turntable will be located 100 ft. from the house, being served by a three-track approach having two tracks for inbound engines and one for outbound engines. Provision is made for a second outbound track on this approach, all four tracks being served by a coaling station with a 600-ton bin spanning three tracks.

A cinder pit 125 ft. long, having a depressed track in the middle for cinder cars, serves the two inbound tracks. A sand storage and drying house is adjacent to the coaling station and connected to it so that engines can take coal and sand at the same time. Space for coal storage piles is provided, the coal to be moved to a hopper which feeds the elevating conveyor of the coaling station. Ample emergency facilities for turning locomotives are provided by the Y-tracks at the east end of the yard and the loop for outgoing westbound engines.

Water for the engines will be pumped to a 100,000-gal. elevated steel tank by duplicate equipments operated by kerosene and electric motors, the supply being



PROFILES OF TEMPORARY AND PERMANENT HUMPS FOR GRAVITY SWITCHING

taken from Kinzie creek which is fed largely by springs and affords a constant supply of soft water that can be used without treatment. Drinking water from wells will be furnished to the buildings, but the wells have not sufficient capacity for the engine supply. Water columns for supplying the engines are located 100 ft. beyond the cinder pits, towards the roundhouse; one water column is provided also on the emergency approach track, about 200 ft. from the roundhouse. Near the west end of the westbound receiving yard will be a water column for convenient supply of the hump engine, but it is not expected that a similar arrangement will be necessary for the eastbound receiving yard, as this is near the engine terminal.

Adjacent to the roundhouse will be an engine repair shop 60 x 483 ft., containing a machine shop and a blacksmith and boiler shop; also an erecting shop 100 x 140 ft. with capacity for six engines. Space is provided for enlarging the building to double this capacity. Other buildings will include a storehouse, oil house and office. All of these will be of brick, with a steel roof for the repair shop. A brick hotel will provide accommodation for enginemen and trainmen whose homes are at the other end of the division. In the city, arrangements are being made by a local company to provide for the housing of the employees now living at Michigan City and who must move to Niles when the new terminal is put in service. This company has laid out subdivisions and built houses, besides inducing other firms and contractors to buy lots and erect houses, so that adequate accommodation will be available.

Grading and Bridges

Filling is required over Kinzie Creek and to build the switching humps, but there is very little cut in the yard proper as the ground is practically level. A cut 20 to 30 ft. deep is required for the eastbound departure yard, along the air-line cut-off. Extra land was purchased here for borrow pits sufficient to supply all filling. As the material is sand and gravel, with a very little clay, it has been found possible to select a fair material for ballasting the yard tracks. For the first unit of the yard the total grading will be about 800,000 cu.yd., while about 1,600,000 cu.yd. in addition will be needed for the completion of the entire layout.

The Niles yard is situated favorably with regard to highway crossings, there being a stretch of two miles from Lake St., which is carried by an overhead bridge, to the first highway. As this road is just beyond the humps it will be diverted so as to pass under them, while the main tracks also will be elevated so as to complete the separation of grades at this point. At both ends of the site are other road diversions.

Kinzie Creek crossed the yard site diagonally by a very crooked channel, but has been diverted to the east end where it will be crossed by three double track lines instead of by a group of 35 tracks. A stub of the old channel is left to serve the yard pumping station. Three 16-ft. I-beam spans with concrete abutments and deck carry the tracks across the stream, which is crossed also by two 16-ft. reinforced concrete slab spans for highways. A 72-in. reinforced concrete pipe will take care of a county drainage ditch that crossed the site and will receive also the drainage from the roundhouse and other buildings. All sewage, however, will be treated in septic tanks before being delivered to this pipe drain.

As the first unit of the work, the westbound receiving and classification yards have been built, with the engine terminal and five of the eight repair tracks, the two yards being temporarily divided longitudinally to provide for both eastbound and westbound business. This method of operation required special temporary connections, including a line from the present eastbound section to the westbound hump. Owing to this arrangement the hump could not be built to full height, its summit being 14 ft. below the final elevation. As designed, the approach grade was 1% which permitted only 300 ft. of 2% gravity grade. This has been improved by the use of a steeper approach grade, as shown in the foregoing table. While this does not permit of full gravity switching, it is of considerable assistance in classifying westbound trains.

Eastbound trains are switched by means of two temporary tail tracks at the west end of the yard, located adjacent to the future westbound departure yard. These are at the original ground level, from 2 ft. to 12 ft. above the main tracks, which are in a cut at this point. Thus the tail tracks avoid the 20-ft. grade which will exist in the departure yard.

This first unit was put in operation in November, 1919. It is expected to handle the present traffic up to about 25 trains each way daily, while the completed yard will have about double this capacity, with trains not exceeding 100 cars. The remainder of the work will be carried out as funds permit and when this is completed the engine terminal will be put in service. Michigan City will then be abandoned as a division point.

The total cost of the yard and equipment complete will be about $4,000,000 and about 700 employees will be required in the yard, shops and engine terminal. On the present unit, the grading and bridge work have been done by the Dominion Construction Co., Toronto, Canada; the buildings were erected by Joseph Nelson & Son, Chicago, and the coaling station by the Link Belt Co.

The general design of the yards and facilities for the new division point at Niles were prepared by W. D. Elder, assistant engineer, under the direction of J. F. Deimling, acting chief engineer of the Michigan Central R.R. during the absence of Col. G. H. Webb, chief engineer, while in Europe with the American expeditionary force. In direct charge of the field work was H. S. Evans, special engineer, who was succeeded by E. P. Phelps, assistant engineer. The buildings and water supply were in charge of H. A. Horning, superintendent of buildings, while the bridge designs were made under the supervision of G. C. Tuthill, bridge engineer.

Train Accidents for Year Reported by I. C. C. Bureau of Safety

The recent annual report of the chief of the Bureau of Safety of the Interstate Commerce Commission for the year which ended June 30, 1919, contains a record of 79 train accidents investigated by the bureau, of which 53 were collisions, 25 were derailments, and one was classed as "miscellaneous." The accidents resulted in the death of 336 persons and the injury of 1333, of whom 261 were killed and 1083 injured in collisions. Three of the derailments were due to defective mechanical equipment; four to track conditions; five to broken rails; three to improper operation of switches; three to poor condition of track; two to washouts, and one to malicious removal of rail connections.

What Is the Future of Inland Water Transportation?—*Part II*

By Charles Whiting Baker
Consulting Editor, Engineering News-Record

Two notable attempts to revive long-distance steamboat transportation on the Mississippi and Missouri Rivers are here described. In both cases the enterprise was backed by ample capital, had the benefit of expert engineering direction and received the enthusiastic support of shippers. In both cases the enterprise met complete financial failure and in the case of the company operating on the Mississippi River, it was explicitly declared that the channel conditions had nothing to do with the company's failure.

Both of these companies undertook to do business by carrying freight at 80 per cent of the railway rates. Their published expense accounts show that the earnings at this rate did not pay the operating expenses of the boats.

In 1915 the shippers who patronized the Missouri River boats saved about $10,000 in reduced cost over railway charges. In order that the Missouri River navigation should be of public benefit commensurate with its cost it would have to save to shippers at least $2,600,000 per annum in freight charges.

V—Continued from page 28

An Experiment in Carrying Merchandise Freight on the Mississippi River

In the voluminous literature on waterway transportation one finds repeatedly the statement that the proper field for the waterway in competition with the railway is the transportation of low-grade freight. The Windom committee of 1872 stated as one of its conclusions that "water routes, when properly located afford the cheapest means of transport for all heavy, bulky and cheap commodities." How meager was the information at the disposal of that committee may be gleaned from its estimate of the cost of improving the Mississippi River for navigation. The committee recommended:

"Improvement of the river, on a system to be provided by the War Department, to give 3½ to 5 ft. above Minneapolis, 4½ to 6 ft. below there to St. Louis, and 8 to 10 ft. at the lowest stages of the water from St. Louis to New Orleans; estimated cost, $5,000,000 plus $114,000 for reservoirs at the source of the river."

The committee's conclusion that the field of the waterway was the carrying of low-grade bulk freight, and, by implication, that the railway held first place for transporting other merchandise, appeared justified half a century ago. No one at that day foresaw the future development of the railway. The standard freight car was then of 10 tons capacity. Cars capable of carrying 100 tons and trainloads of 3000 tons were undreamed of.

The effect of the development in railway unit loads on the economics of transportation is little understood by the general public. One still hears the old-time argument that waterway competition will be a benefit to the railway because the waterway will relieve the railway of the unprofitable burden of carrying low-grade freight at low rates! On the other hand, the up-to-date promoters of motor-truck transport are today urging that local merchandise freight and express business should be turned over to the trucks, leaving the railway free to handle the heavy freight and the long-distance business to which it is adapted!

Of these two contradictory statements, the latter is nearer the truth. The railway of the present day, with its large capacity rolling stock, can handle full carloads and full trainloads, where the volume of traffic is sufficiently heavy, and make a profit from a freight rate which would have seemed incredibly small half a century ago.

The determining factor in the transfer of bulk freight from the river to the railway has not been the low cost of transport alone but the low cost of handling at the terminals. The railway's hopper-bottom car carries its burden to its final destination and then dumps, by gravity, its load of coal or ore or stone. Save for the rare cases where the cargo of a boat has its final destination at a plant on a waterfront, bulk freight sent by water must stand the cost of a transfer from boat to car and often of a double transfer; and a boat's cargo always has to be hoisted out from below water level.

Water Transport for Merchandise Freight

Those who have recognized the controlling influence of transfer costs in transport at the present day have seen a possibility that the waterway might come back as an avenue for merchandise freight. Railway freight rates on first- and second-class merchandise freight, especially for less-than-carload shipments, are so much higher than the rates on low-grade bulk freight that the water route can carry goods at a differential below the rail rates and still charge a far higher price for its service than in hauling bulk freights.

Most important of all, the cost of transfer at terminals is a much smaller percentage of the total freight rates in the case of first-class merchandise than it is of low-grade freight. The commercial organizations, also, which stand sponsor for the waterway propaganda, are generally much more interested in the rates on merchandise than on bulk freights, more anxious to see water competition established in this field, and more inclined to liberal support of a water line which carries general merchandise shipments.

In the spring of 1916, there was begun a very interesting experiment in the transportation of merchandise freight on the Mississippi River between St. Louis and New Orleans. The Inland Navigation Co., with an authorized capitalization of $3,000,000, undertook to build and operate on the Mississippi River a

line of steel barges propelled by oil engines. The president of the company, John H. Bernhard, is an engineer; and the plans of the enterprise were worked out with much ingenuity to reduce the labor cost and delays in handling goods in terminals. The company's general plan was to operate self-propelled barges of about 1400 tons nominal capacity and to give regular service between St. Louis and New Orleans with one intermediate stop at Memphis, to take on and discharge freight.

One boat, the "Inco No. 1," was completed, and made 19 trips between New Orleans and St. Louis between Mar. 24, 1916, and July 31, 1917. The total amount of freight carried on these 19 trips was 12,745 tons, or an average of 670 tons per trip, about two-thirds of the boat's capacity. The average freight rate received was $4.24 per ton. The total earnings from all freight carried were $54,046. From this there was deducted, for drayage, switching and other transfer charges paid by the Navigation company, $8072, leaving net freight receipts of $45,973. During this time the company paid out in terminal expenses for stevedoring etc., $24,154, and in the operation of its barges $76,302, making a total of $100,456 direct operating expenses, and this does not include anything for interest and depreciation on investment. In addition to this, the company incurred general administration expenses, in connection with its enterprise, amounting to $116,362, so that its expenses exceeded its receipts by about $171,000.

When an enterprise meets with financial disaster, the details of its experience are usually unobtainable. Mr. Bernhard, however, with commendable public spirit, has made available complete records of the operation of his experimental barge and of the company which he organized to exploit it, from which records the above figures are taken.

Why the "Inco" Failed

Mr. Bernhard ascribed the lack of success of his boat to two principal causes: First, an unsuccessful equipment of oil engines which caused great expense and serious delays in the operation of the boat, and, second, the very heavy expense at the terminals. More than 30% of the boat's time was spent lying at the wharves; this was due to the inefficiency of the terminals. The rate of receiving or discharging cargo averaged only 10 tons per hour, notwithstanding the fact that the boat was equipped with special cargo-handling machinery for the express purpose of lessening the labor cost and expediting the time spent in loading and unloading. Including loss and damage to freight at terminals, the total terminal expenses on the 12,745 tons carried averaged $2.45 per ton. The cost of operating the barge on the trips was excessive for the reasons above set forth; but had it been possible to run the barges as economically as the designers expected, the handling of freight at the terminals would have cost fully half as much as the cost of carrying it all the way from St. Louis to New Orleans.

It is of especial interest to note that no part whatever of the failure of the enterprise can be assigned to the condition of the river channel. For many years Mississippi steamboat operators complained that the depth of the water claimed by the Government engineers was not actually available, and that a large part of the difficulty of the river craft in competition with the railways was due to the channel conditions. Mr. Bernhard explicity states, however, that the delay caused by the condition of the channel to the "Inco No. 1" was only a few hours for the 19 trips which she made.

Effect of Partial Loading on Costs

The experience of the Inland Navigation Co. illustrates well how deceptive figures for the cost of water transport may be which are based on the direct expenditures for the movement of the boat alone. On one of the trips of the "Inco No. 1" from St. Louis to New Orleans the direct operating expenses for the 10-day trip were only $1148. She carried about 500 tons of freight and earned $2456. Had she carried her full load of 1400 tons, and received an average freight rate of $5 per ton, her earnings on this trip would have been $7000. The cost for the voyage of 1200 miles, had she carried her full theoretical load, would have amounted to only two-thirds of a mill per ton-mile.

This looks like an enormously profitable business; but when the actual conditions are studied a different picture is seen. The carriage of merchandise freight is entirely different from the carriage of coal or other bulk freight. The boat carrying merchandise must make most of her voyages with only a partial cargo, and the river carrier is no exception to the rule.

While the "Inco No. 1" had a capacity for 1400 tons dead weight, about 1100 tons of general merchandise filled all her space; and her average load on the 19 voyages was only 670 tons. Mr. Bernhard believes the failure to obtain full loads for the boat was due to the difficulties with the engines that made it impossible to give regular service. He even computes that his company would have earned a profit if it had been able to operate regularly for the full season and carry its full load of 1400 tons on every voyage.

Waterway literature is full of theoretical computations of the cost of water transport based on the assumption of boats running always fully loaded, with no allowance for delays. But no transportation business ever enjoys such favorable conditions. The water carrier, like the rail carrier, must cope with great variations in the volume of traffic moving in different directions and at different seasons. This is especially the case where a steamboat gives a regular schedule service, as she must do to carry merchandise freight. She has to sail on a definite day, whether she has obtained a full cargo or merely a partial one. She must have capacity enough, too, to carry the business offered. If she leaves freight on the dock when she sails, the shipper will send his next consignment by rail. Again, as the business is open to free competition there is always the chance that competing boats will take away part of the traffic. For all these and other reasons, it is obvious that the boat carrying merchandise freight can only count on partial loads in estimating her earnings.

And again, in any transportation business the direct expenses are only a part of the operating costs. The overhead expenses have to be met as surely as the bills for coal and oil and crews' wages; and the overhead expenses of an organization able to do business in a modern way and render such service as a railway renders cannot be brought down to any small sum.

The experience of the "Inco No. 1" also sheds light on the favorite theory that large-capacity carriers are an essential feature for economical operation. This

is true where the volume of business is sufficient and where terminal conditions are such as to permit rapid loading and discharging of cargo, as in the handling of ore on the Lakes. The "Inco No. 1" would have made no greater success had she been of 2000-ton instead of 1000-ton capacity. Any saving in the expenses per ton carried on the voyage would have been more than offset by the longer delays in port to load and discharge cargo.

VI—The Missouri River Improvement

Steamboat transportation on the Missouri River during the pioneer days of the West was of great value. As early as 1819 the first steamboat ascended the river to Council Bluffs. For many years the river was the chief means of transport west from the Mississippi to the frontier states of Kansas and Nebraska.

While the river was being used by steamboats prior to 1870, the Government spent very little on its improvement. It was not until 1878, when agitation over railway competition with water routes had become active, that Congress began to make large appropriations to improve the Missouri River. Yet, by this time the impotence of the shallow-draft Missouri River steamboat, subject to perils of snags and sandbars, to compete with the railways had become manifest. Nevertheless, Government work on the river continued; and it was not till 1902, when between seven and eight million dollars had been spent on the river, that Congress abolished the Missouri River Commission and suspended work on the river.

Renewal of Work on the River

The waterway agitation was most active during the years from 1900 to 1907, culminating in that year in President Roosevelt's appointment of the Inland Waterways Commission, before referred to. Urged by this agitation, Congress in 1907 ordered a preliminary survey to determine whether the Missouri was worth improvement for navigation. In response to this order a project was worked out by the Army engineers and recommended to Congress, for the improvement of the river from Kansas City to the mouth, at an estimated cost of $20,000,000, and an estimated annual expenditure for maintenance of $500,000.

The first appropriation of $1,000,000 for this work was contained in the rivers and harbors bill of 1910. Hon. Theodore E. Burton of Ohio had long been chairman of the rivers and harbors committee of the House, and was then in the Senate. Mr. Burton had been chairman of the Inland Waterways Commission in 1907 and had become aware how far river navigation had declined. As a member of the Senate committee he was instrumental in having inserted in the bill a provision requiring reëxamination of the project by a special board of engineers. This board was appointed. It approved the project, and in the rivers and harbors act of 1912 Congress formally adopted it.

The Deakyne Report

Three years later, after $6,250,000 had been appropriated for the work, Congress ordered a reëxamination of the Missouri River. In response, the engineer officer in charge of the district, Lieut. Col. Herbert Deakyne, submitted a report, the gist of which was as follows: Of the 309,684 tons of traffic on the river, floating logs and sand and gravel dredged from the river accounted for all but 37,551 tons. The total freight charge on this 37,551 tons of freight was about $41,000, and as the river freight rate was 80% of the rail rate the saving to shippers by the use of the river was about $10,000. Assuming that the Government could borrow money at 3%, its investment of $20,000,000 in improving the river would represent an annual fixed charge of $600,000. Adding to this the annual maintenance charge of $500,000 gave a total of $1,100,000 as the total annual cost of the river improvement.

"The improvement must stand or fall," said Lieutenant Colonel Deakyne, "on the question of prospective commerce." Regarding this he said that the Mississippi River, from Cairo to New Orleans, which had for many years had a navigable depth of over 6 ft. and was far better situated to attract a heavy traffic than the Missouri, carried, in 1913, only 258,709 tons. "If the Mississippi, under these conditions and with a 6-ft. channel, carries only this amount, it seems to me very doubtful whether the Missouri, at the same depth, would carry any more. . . . The Missouri River traffic would have to increase sevenfold to equal the Mississippi traffic, and more than a hundredfold to reach a figure commensurate with the cost of the work."

Lieutenant Colonel Deakyne's report stirred up a hornets' nest. From Minneapolis to New Orleans the organizations formed to promote waterway development rallied all their forces for defense. The newspapers outdid one another in attacks upon the engineer who had the courage to state the facts and express opinions contrary to those of his predecessors and superiors on whose recommendation the project had been adopted.

Colonel Townsend Approves Deakyne's Report

Lieutenant Colonel Deakyne's immediate superior, Col. C. McD. Townsend, however, approved his recommendation and said:

> It is believed that there is still opportunity for the revival of Western river commerce, but it should first be sought not on the tributaries but on the main river. There is neither the density of population nor the material seeking shipment on the tributaries of the Mississippi (except the Ohio) to cause such a revival. . . . The failure to utilize properly the improved channel from St. Louis to New Orleans should cause Congress to hesitate before continuing the large appropriations it is making for the Western rivers. . . . An opportunity should be afforded the American people to determine whether they want waterways, not by rhetorical efforts in river conventions but by practical utilization of the channels. Until such revival occurs, appropriations should be confined to maintaining the existing status.

The Board of Engineers for Rivers and Harbors, of which Col. W. M. Black (who later became a Major General and chief of engineers) was chairman, disapproved Lieutenant Colonel Deakyne's report after a hearing at Kansas City at which a great mass of testimony was presented favorable to the improvement. The most important of this testimony related to the operations of the Kansas City River Navigation Co. This company was organized in 1912 and raised about $1,000,000 by popular subscriptions among the business men of Kansas City. It operated in 1915 a fleet of two towboats and 13 steel barges. It had expended a considerable amount in experimental work to develop the most economical methods of river navigation, and the board of 1915 declared that it was "the most thorough

attempt within the knowledge of the board to revive a river traffic that had disappeared under railway competition."

The avowed purpose of this boat line was to demonstrate the possibilities of profitable conduct of river transport at the present day in competition with the railway. Its rates on freight were fixed at 80% of the rail rate. It established a regular traffic department for getting business, and obtained joint rates with the railway companies and switching arrangements so that freight loaded at any switch track in Kansas City could be transferred to the terminal for loading on its boats.

Results of the Kansas City Boat Line

It is of interest, therefore, to see what results the company obtained. These may be briefly summarized as follows from its own report to the Board of Engineers, Oct. 30, 1915:

	1913	1914	1915 to Oct. 1
Total tons carried	9,784	13,677	27,306
Cost of operation per ton carried	$5.09	$4.04	$2.06
Cost of wharf labor, per ton carried	.81	.63	.66
Cost of transportation, per ton mile, mills.	10.3	8.4	3.58

Of these figures, the first two years represent more or less experimental operation while the business was getting started. In 1915, however, the company was operating a considerable fleet, and by its own statement was getting, much of the time, more freight than it could carry. Its cost of transportation in that year, however, *was more than its receipts from freight.* In other words, instead of demonstrating the advantage in cheapness of river transport over rail, the company's statement shows that it was carrying freight at less than rail rates by using part of its capital to pay running expenses.

Just how great was its deficit, the company gave no figures to show. The operating expenses on which the above figures are based, however, appear to be the cost of operating its boats and terminals alone. They do not include the overhead expenses of the organization, nor is anything whatever included for interest and depreciation on the company's investment in its fleet of boats, amounting to about $600,000. Allowing 6% for interest and only 5% for depreciation, the annual capital charge of the company was about $66,000, or about $2 per ton for every ton carried on its boats in 1915.

The record of the investigation of Missouri River navigation is a bulky volume known as "House Document No. 463, 64th Congress, 1st Session." One may search through all its 303 pages, and nowhere will he find an answer to the question, How can river transportation be conducted at a lower cost than railway transportation? There is no end of testimony from those who expatiated on the great advantage of the river transport over the railway on the *assumption* that it was cheaper; but it was all assumption.

The good faith of the pioneers and managers of the Kansas City River Navigation Co. is not questioned. They believed, as thousands of business men believe, that water transportation is inherently cheaper than railway transportation and that the commercial prosperity of their section depended on its reëstablishment. They found over 400 business firms and persons in their section who believed the same thing and were willing to back their belief by subscribing a few dollars or a few hundred dollars to a company to demonstrate this. The company spent nearly $1,000,000 in endeavoring to establish its business; but it never came within gunshot of carrying freight as cheaply as the railways, when all the elements of cost were taken into consideration. It brought down its operating expenses to a very moderate figure, as shown above; but it failed wholly to show any prospect of profit from the operation of boat lines such as would encourage capital to invest in such lines as a business.

If there had been any profit or any prospect of profit in the business, the company would have undoubtedly continued in it; but after paying deficits out of capital every year from its organization, it seized the opportunity, when the Federal Railroad Administration undertook to operate inland waterways in 1917, to sell its boats to the Government and discontinue its business.

Improvement to Benefit Riparian Owners

There are two features in the extended investigation of this Missouri River project which deserve special attention. One is that one of the underlying motives for the agitation to have the United States improve the Missouri for navigation was to benefit the lands along the river. The owners of these lands and the communities interested are, of course, desirous of having the revetment of the river banks done at Federal expense. The Mississippi River precedent works in their favor. But if the Federal treasury is to be tapped to benefit owners of river bottom lands on the pretext of navigation improvement, the door will be opened to the spending of two dollars of public money to effect one dollar of benefit to the private individual. That way lies national bankruptcy.

No less dangerous is the argument, which occurs repeatedly in the hearing, that in computing the cost of a navigation improvement no allowance should be made for interest on the money which the Government expends. In other words it was seriously argued —and argued by members of Congress—that the Government ought to invest money in transportation improvements without any regard to whether the investment would effect an annual saving in transportation cost at least equal to the interest on the investment.

At the present time, with Government control and operation of the railways in force, the danger of this principle must be obvious to anyone. All possibilities of economy in Government operation of the railways or any other business are at an end if the question, "Will it pay?" may not be raised before undertaking any Government work.

How Much Must the Missouri River Earn in Order to Pay?

Turning back to the present condition of the Missouri River work: The latest report of the engineer in charge shows that between seven and eight million dollars has been spent on the work, and it is only about 27% completed. The great advance in labor and material will probably at least double the cost estimates of 1910 before the work is complete. That is to say, the 6-ft. deep channel will cost perhaps $40,000,000 to make and $1,000,000 annually to maintain. The interest charge on the work, too, can no longer be set at 3% as in 1910, but must be raised to at least 4% in view

of prevailing rates on Government bonds. In other words, if the Missouri River improvement is worth making, it must show a saving in transportation costs equal to at least $2,600,000 per annum.

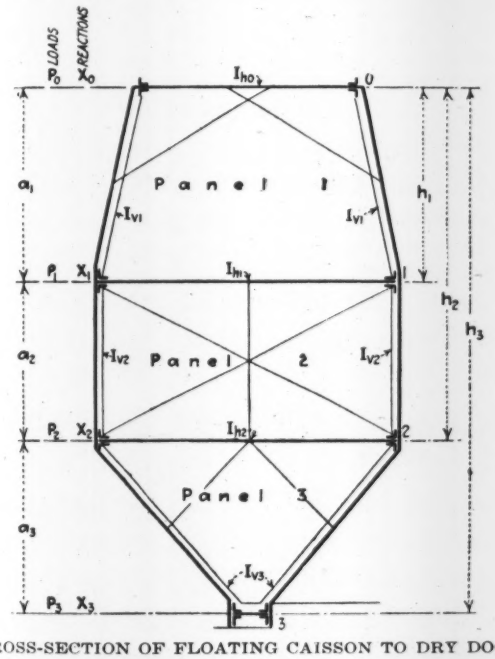
(To Be Continued)

Structural Design of Caisson Gates for Dry Docks

Theoretical Design, Using Method of Least Work With Practical Application to Actual Caisson Structure

By Eugene E. Halmos
Designing Engineer, Barclay Parsons & Klapp, New York City

CAISSON gates have almost universally replaced the earlier miter gates for the purpose of closing the entrance of modern graving docks. Two types of caisson gates have been developed: The sliding or rolling caisson, which is drawn back into a recess at the side for opening the dock, and the ship caisson, so-called from its resemblance in section to the hull of a ship which is floated into position and sunk into its seat by the admission of water in the ballast chamber of the gate. Ship caissons are extensively used in this country, and the figure and example shown in the present article



CROSS-SECTION OF FLOATING CAISSON TO DRY DOCK

refer to such gates. The formulas, however, hold good for the sliding caissons also.

The caisson types of gates are built of steel or of reinforced concrete. They consist essentially of a number of horizontal girders and vertical frames, the whole covered by water-tight plating. The thrust of the water against the gate is resisted at the two side sills and the bottom sill—in other words, at three sides of the nearly rectangular structure (the sides, as a rule, having a slight batter), making it statically indeterminate.

However, with the help of certain permissible assumptions, the stresses in the several members of the structure can be determined by applying the principle of least work. The method of finding the stresses in miter gates by application of this principle was presented in Vol. 81, *Trans. Am. Soc. C. E.*, by H. Goldmark. Most of the notations in the present article are identical with those used by Mr Goldmark.

I. Theory

For the purposes of this demonstration it will be assumed:

1. That the gate consists of three horizontal girders and a keel (see drawing herewith).
2. That the water load is transmitted to the horizontals by the skin plates.
3. That the vertical frames are numerous enough to permit considering them as forming together with the skin plates, one integral vertical girder, the stiffness of which is evenly distributed along the length of the gate.
4. That there is perfect contact between the keel of the caisson and the bottom sill of the dock—in other words, that the keel (or, in case of sliding caissons, the lowest horizontal girder) cannot take bending stresses, not being able to deflect.

If the horizontal girders were so proportioned as to be stressed to the same unit stress under the water load tributary to each of them, and if the lowermost girder were free to deflect, it is evident that the elastic deformation of each girder would be the same, and no bending stress due to the thrust of water would be developed in the vertical girder.

The horizontal girders, however, are given dimensions with regard to other considerations than the water load only. The top girder is very often used as the floor of a bridge; the next horizontal forms the floor of the operating chamber, and frequently has substantial fender attachments, etc. Furthermore, as perfect sill contact is assumed at the keel, the deflection of the horizontals will always be unequal, and the stiffness of the vertical girder will result in transmitting part of the water-load upon the sill and in changing the load taken by the horizontals by positive or negative reactions on same.

Let

L_0, L_1, L_2 and L_3 = the lengths of the horizontal girders;
P_0, P_1, P_2 and P_3 = the direct water load on same per unit length;
x_0, x_1, x_2 and x_3 = the reactions of the vertical girder upon the horizontals, per unit length,

then the total load upon the horizontals will be:

$(P_0 + x_0)\ L_0$, $(P_1 + x_1)\ L_1$, $(P_2 + x_2)\ L_2$ and $(P_3 + x_3)\ L_3$, which latter is the sill reaction in the case here considered.

The horizontals divide the vertical girder into three panels. If L denotes the average length of the caisson, the forces acting on the vertical girder at the panel-points will be

$$x_0L,\ x_1L,\ x_2L \text{ and } x_3L.$$

The vertical girder will be in equilibrium, if

$$\Sigma x = x_0 + x_1 + x_2 + x_3 = 0 \qquad (1)$$

and $$\Sigma M = x_0h_3 + x_1(h_3 - h_1) + x_2(h_3 - h_2) = 0 \qquad (2)$$

In order to solve the four unknown reactions, two more equations are necessary, which will be furnished by the principle of least work. Let

W = the total work done by the internal forces upon the gate;

W_h = the work done in bending the horizontal girders;
W_v = the work done in bending the vertical girder, then

$$W = W_h + W_v$$

Furthermore, let

M_{h_0}, M_{h_1} and M_{h_2} = the bending moment at any cross-section of the horizontal girders 0, 1 and 2;

M_{v_1}, M_{v_2} and M_{v_3} = the bending moment at any point of the vertical girder in each of the panels 1, 2 and 3;

I_{h_0}, I_{h_1} and I_{h_2} = the moment of inertia of the horizontals;

I_{v_1}, I_{v_2} and I_{v_3} = the moment of inertia of the vertical girder in each panel;

l = the distance of any point of the horizontal girders from the left support;

y = the distance of any point of the vertical girder from the upper panel-point in each panel;

E = the modulus of elasticity (supposed to be constant), then

$$W = \frac{1}{2E}\left(\int_o^{L_0}\frac{M_{h_0}^2}{I_{h_0}}dl + \int_o^{L_1}\frac{M_{h_1}^2}{I_{h_1}}dl + \int_o^{L_2}\frac{M_{h_2}^2}{I_{h_2}}dl + \int_o^{a_1}\frac{M_{v_1}^2}{I_{v_1}}dy + \int_o^{a_2}\frac{M_{v_2}^2}{I_{v_2}}dy + \int_o^{a_3}\frac{M_{v_3}^2}{I_{v_3}}dy\right)$$

If now M_h and M_v are expressed in terms of x_0, x_1, x_2 and x_3, in order to make the work a minimum, the partial derivatives of W with respect to the unknown reactions must all become equal to zero. However, as x_2 and x_3 can be expressed in terms of x_0 and x_1, the two equations of the form

$$\frac{\delta W}{\delta x_0} = 0 \text{ and } \frac{\delta W}{\delta x_1} = 0$$

will result.

In the above expression, for W the first three integrals represent the work of the internal forces in bending the horizontal girders 0, 1 and 2—girder 3 being omitted, for it is assumed that this girder does not take bending stresses but transmits the loads directly to the sill. The last three integrals represent the work done in bending the vertical girder.

II. Development of Working Formulas

From equations (1) and (2)

$$x_2 = -(x_0 + x_1 + x_2) \quad (3)$$

$$x_2 = -\frac{x_0 h_3 + x_1(h_3 - h_1)}{h_3 - h_2} \quad (4)$$

As the relative position of the horizontal girders is known from the preliminary design, the numerical values of the coefficients of x_0 and x_1 can be readily determined. In the example here given, $h_1 = 9$ ft., $h_2 = 16.33$ ft., $h_3 = 24.33$ feet.

Therefore, from (4)

$$x_2 = -(3.04\,x_0 + 1.92\,x_1) \quad (5)$$

and, substituting this value in (3)

$$x_3 = 2.04\,x_0 + 0.92\,x_1 \quad (6)$$

In the evaluation of $\frac{\delta W}{\delta x_0}$ and $\frac{\delta W}{\delta x_1}$ it may be seen that the factor $\frac{1}{E}$, being common to all members, can be omitted. It will also be assumed that the moment of inertia of each horizontal girder and of each panel of the vertical girder is constant and its value known from the preliminary design.

Horizontal Girders

In general

$$\frac{\delta W_h}{\delta x} = \frac{1}{I_h}\int_o^L M_h \frac{\delta M_h}{\delta x}\,dl, \text{ where}$$

$$M_h = \tfrac{1}{2}\,L\,(P + x)\left(l - \frac{l^2}{L}\right) \text{ and}$$

$$\frac{\delta M_h}{\delta x} = \tfrac{1}{2}L\left(l - \frac{l^2}{L}\right)$$

Derivatives with respect to x_0

Girder No. 0 $\frac{\delta W_{h_0}}{\delta x_0} = \frac{L_0^5}{120\,I_{h_0}}(P_0 + x_0)$

Girder No. 1 $\frac{\delta W_{h_1}}{\delta x_0} = 0$

Girder No. 2 $\frac{\delta W_{h_2}}{\delta x_0} = -\frac{3.04\,L_2^5}{120\,I_{h_2}}(P_2 - 3.04\,x_0 - 1.92\,x_1)$

Derivatives in the respect to x_1,

Girder No. 0 $\frac{\delta W_{h_0}}{\delta x_1} = 0$

Girder No. 1 $\frac{\delta W_{h_1}}{\delta x_1} = \frac{L_1^5}{120\,I_{L_1}}(P_1 + x_1)$

Girder No. 2 $\frac{\delta W_{h_2}}{\delta x_1} = -\frac{1.92\,L_2^5}{120\,I_{h_2}}(P_2 - 3.04\,x_0 - 1.92\,x_1)$

Vertical Girder.

In general.

$$\frac{\delta W_v}{\delta x} = \frac{1}{I_v}\int_o M_v \frac{\delta M_v}{\delta x}\,dy.$$

The bending moments in the three panels and their derivatives with respect to x_0 and x_1 can be expressed as follows:

$$M_{v1} = Lx_0y, \quad \frac{\delta M_{v1}}{\delta x_0} = Ly, \quad \frac{\delta M_{v1}}{\delta x_1} = 0$$

$$M_{v_2} = L\,[x_0\,(h_1 + y) + x_1 y], \quad \frac{\delta M_{v2}}{\delta x_0} = L\,(h_1 + y), \quad \frac{\delta M_{v2}}{\delta x_1} = Ly$$

$$M_{v_3} = L\,[x_0\,(h_2 - 2.04y) + x_1\,(h_2 - h_1 - 0.92y)]$$

$$\frac{\delta M_{v3}}{\delta x_0} = L\,(h_2 - 2.04\,y), \quad \frac{\delta M_{v2}}{\delta x_1} = L\,(h_2 - h_1 - 0.92y)$$

Derivatives with respect to x_0

Panel No. 1 $\frac{\delta W_{v1}}{\delta x_0} = \frac{L^2}{I_{v1}}\,\tfrac{1}{3}a_1^3 x_0$

Panel No. 2 $\frac{\delta W_{v2}}{\delta x_0} = \frac{L^2}{I_{v2}}\left[x_0\left(h_1^2 a_2 + h_1 a_2^2 + \frac{a_2^3}{3}\right) + x_1\left(h_1\frac{a_2^2}{2} + \frac{a_2^3}{3}\right)\right]$

Panel No. 3 $\frac{\delta W_{v3}}{\delta x_0} = \frac{L^2}{I_{v3}}[x_0\,(h_2^2 a_3 - 2.04\,h_2 a_3^2 + 1.39\,a_3^3) + x_1\,(h_2^2 a_3 - h_1 h_2 a_3 - 1.48\,h_2 a_3^2 + 1.02\,h_1 a_3^2 + 0.63\,a_3^3)]$.

Derivatives with respect to x_1

Panel No. 1 $\frac{\delta W_{v1}}{\delta x_1} = 0$

Panel No. 2 $\frac{\delta W_{v2}}{\delta x_1} = \frac{L^2}{I_{v2}}\left[x_0\left(h_1\frac{a_2^2}{2} + \frac{a_2^3}{3}\right) + x_1\frac{a_2^3}{3}\right]$

Panel No. 3 $\frac{\delta W_{v_3}}{\delta x_1} = \frac{L^3}{I_{v_3}} [x_0(h_2^2 a_3 - 1.48\, h_2 a_3^2 - h_1 h_2 a_3 + 1.02\, h_1 a_3^2 + 0.63\, a_3^3 + x_1\,(h_2^2 a_3 - 2h_1 h_2 a_3 - 0.92\, h_2 a_3^2 + h_1^2 a_3 + 0.92\, h_1 a_3^2 + 0.29\, a_3^3)]$.

All terms representing derivatives with respect to x_0 are then collected and equated to zero, and the same is done with terms representing derivatives with respect to x_1. The equations $\frac{\delta W}{\delta x_0} = 0$ and $\frac{\delta W}{\delta x_1} = 0$ are thus obtained, which, together with equations (5) and (6) will solve to four unknown reactions.

III.—Numerical Example

The cross-sectional sketch shown on the figure represents the general shape of a caisson gate designed for a shallow dry dock.

The dimensions in feet and direct waterloads in lbs. per linear foot are as follows:

$a_1 = 9$ ft.	$L_1 = 65.5$
$a_2 = 7.33$	$L_2 = 63.5$
$a_3 = 8$	$L_3 = 65.5$
$h_1 = 9$	$P_0 = 255$
$h_2 = 16.33$	$P_1 = 2900.$
$h_3 = 24.33$	$P_2 = 6540.$
$L_0 = 67.5$	$P_3 = 3820.$

As a first trial, the following moments of inertia were used:

$I_{h0} = 4.2$ ft.^{4}	$I_{v_1} = 21.2$ ft.^{4}
$I_{h_1} = 17.5$ ft.^{4}	$I_{v_2} = 82.5$ ft.^{4}
$I_{h_2} = 17$ ft.^{4}	$I_{v_3} = 70.5$ ft.^{4}

The resulting simultaneous equations are:

$$x_2 = -(3.04\, x_0 + 1.92\, x_1)$$

$$x_3 = 2.04\, x_0 + 0.92\, x_1$$

$$7{,}635{,}100\, x_0 + 2{,}999{,}650\, x_1 - 9{,}314{,}000{,}000 = 0$$

$$2{,}999{,}650\, x_0 + 2{,}462{,}290\, x_1 - 4{,}580{,}000{,}000 = 0$$

The solution furnished the following values:

$x_0 = +$ 900 lb. per linear foot.
$x_1 = +$ 780 lb. per linear foot.
$x_2 = -$ 4200 lb. per linear foot.
$x_3 = +$ 2520 lb. per linear foot.

The unit loading of the horizontal girders, therefore, was:

$P_0 + x_0 = 1155$ lb. per linear foot.
$P_1 + x_1 = 3680$ lb. per linear foot.
$P_2 + x_2 = 2340$ lb. per linear foot.
$P_3 + x_3 = 6340$ lb. per linear foot (on the sill).

It can be seen that girder 0 is seriously overstressed, while girder 2 is greatly relieved through the influence of the vertical framing and sheathing.

The bending stresses calculated by this method will represent the total actual bending stresses induced in the horizontal girders by the water load. The webs of these members, however, should be made strong enough to withstand vertical loads, such as live load moving across the top of the gate, live load in the operating chamber, load of machinery and ballast placed on the web plates. In dimensioning the vertical framing, the weight of the structure carried by these frames, and local bending due to water load actually carried by the members of same, must be considered besides the loading found by the above method.

Proposed Irrigation Projects in Canada, Brazil and Palestine

SUMMARIZED notes on irrigation in foreign countries, from commercial reports given in the December *Reclamation Record*, indicate three fertile fields for irrigation engineers seeking activity out of the country.

Canada is probably furthest along. It has various projects affecting territory in the vicinity of Lethbridge, one in the Medicine Hat district, and a large scheme for obtaining water from the North Saskatchewan, near Rocky Mountain House, for the irrigation of a portion of eastern Alberta and western Saskatchewan.

In northeastern Brazil since 1877 more than 1,000,000 persons have starved, but irrigation from prospective stored water in one state alone would serve 2,400,000 acres. To the Brazilian national Congress in September President Pessoa recommended legislation permitting Governmental reclamation on a large scale involving the expenditure of $55,000,000.

A Palestine power and irrigation project has been proposed to meet the probable large-scale colonization of the Holy Land. A Norwegian engineer, Albert Hiorth, in the *Norwegian Trade Review* proposes a series of great power stations, utilizing, by means of a 37-mile tunnel, the difference in level between the Mediterranean and the Dead Sea. In addition to ordinary public utility uses, the power would be used for producing lime nitrate from the air, and for an irrigation pumping project involving a lowering of the Sea of Galilee. There are also proposed canals along the Jordan Valley, and dams regulating flood flows; reclaiming the shallow southern part of the Dead Sea by means of a dam from Lisan westward; mining asphalt in the plains of Sodom and Gomorrah. Altogether, several hundred thousand acres would be reclaimed, possibly including the plain of Sharon. The estimated cost of the tunnel is $40,000,000 and of the power plant, canals, etc., $20,000,000.

Specifications for Gas Hose Worked Out by Tests

Research work of much practical value has been done by the Bureau of Standards in investigating the strength of flexible tubing for gas connections. Several dozen different kinds of tubing were examined, according to a full report of results given by R. S. McBride and W. M. Berry in Technologic Paper 133, recently published. The test work was based on a specification previously formulated by the American Gas Institute and the National Commercial Gas Association, and it revealed that various clauses of this specification are unduly severe, while others are not sufficiently definite; a revised specification is therefore proposed.

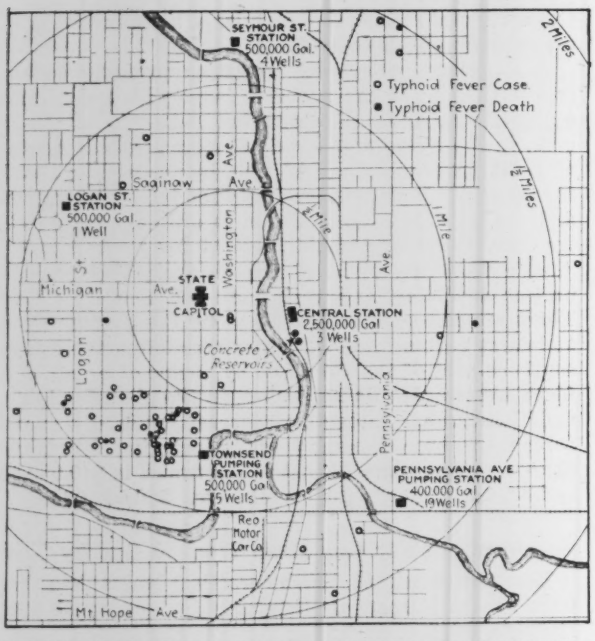
Chief among the requirements proposed are: A crushing resistance of at least 100 lb. per linear inch; a longitudinal tensile resistance of 75 lb.; ability to withstand a twist of 180° per foot or a moment of 2 lb. at an arm of 12 in.; flexibility sufficient to permit bending at 32° F. into a circle of 6-in. diameter, and kinking resistance sufficient to resist a pull of 2 to 8 lb. (according to flexibility) when the hose is bent into such a loop; no leakage greater than 0.02 cu.ft. per hour on a 6-ft. length, after any one of the preceding tests; freedom from softening after 24 hours at 125° F. moist heat; and end tips so securely attached that they will stand the strength tests mentioned.

Water-Supply Typhoid Outbreak at Lansing, Michigan

Wells with Leaky Casings Were Polluted by Sewage Forced Into the Soil During High Water in Grand River, March, 1919

By J. R. Daugherty
Assistant Engineer, State Department of Health

A WATER SUPPLY of 8,000,000 gal. daily is obtained by the City of Lansing from 32 artesian wells, 350 to 400 ft. deep in the "coal-measure" sandstone, the wells being cased into the rock, which is covered with 20 to 100 ft. of sand, gravel and mixed clay. There are five stations pumping directly into the mains, as shown by the accompanying map. The physical properties of the water, the depth of the wells and the absence of epidemics or sickness all tended to create a false sense of security which our investigations have proved was not based on fact. The top of the rock is coarse, poorly cemented and very likely to fissure, so that even though the casings were driven 3 to 5 ft. into rock they are not pollution-proof. There were neither thorough and regular investigations of the lead joints between suction pipes and casings nor any attempts made to build the frost pits water-tight, with the result that the piping was under water much of the time.



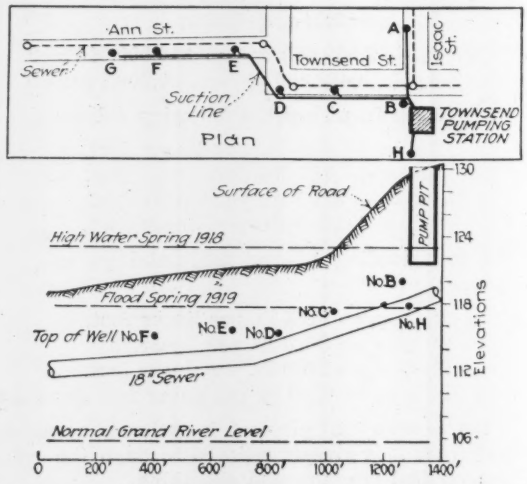
LOCATION OF WELLS AND TYPHOID CASES AT LANSING

During high water in the Grand River it had been usual to shut down the Townsend St. substation, owing to its location near the river, the proximity of the sewer, and the suspicion that it was the cause of a smaller epidemic in 1906. These wells being above the sewer and about 10 ft. higher than normal river level, as shown in the plan and section, more frequent pollution was thus avoided. While the station was shut down during floods, the artesian head prevented any flow of surface water into the pipes or else kept the dilution so high that no sickness resulted.

Heavy rains caused the Grand River to rise 8 ft. Mar. 16, 1919, reaching a stage of 12 ft., which placed a static head of 2½ ft. on the sewer at the wells and forced concentrated sewage into the sandy soil around them. Through an oversight the Townsend St. station was not shut down and the 22-in. vacuum generally maintained on the suction line pulled in so great a quantity of this seepage that dysentery was epidemic by the 18th. On the 19th the State Department of Health was notified of the condition and the first sample was taken. The station was ordered shut off and connected so as to pump to waste, thereby removing polluted water from the wells and enabling sampling to be begun.

At this time the Seymour station alone showed safe, all the other stations being either unsafe or suspicious, and samples from the mains in various parts of the city showed a wide distribution of polluted water. On Mar. 20 the people were notified to boil the water and the Water Board was directed to send a rush order for chlorine for use with our two emergency chlorine machines. Continued flushing of dead ends was also ordered, and this helped remove the polluted water from the mains. Chlorine at the rate of 1.5 p.p.m. at the Central and Pennsylvania stations started Mar. 25, and had the mains sterile by Mar. 29.

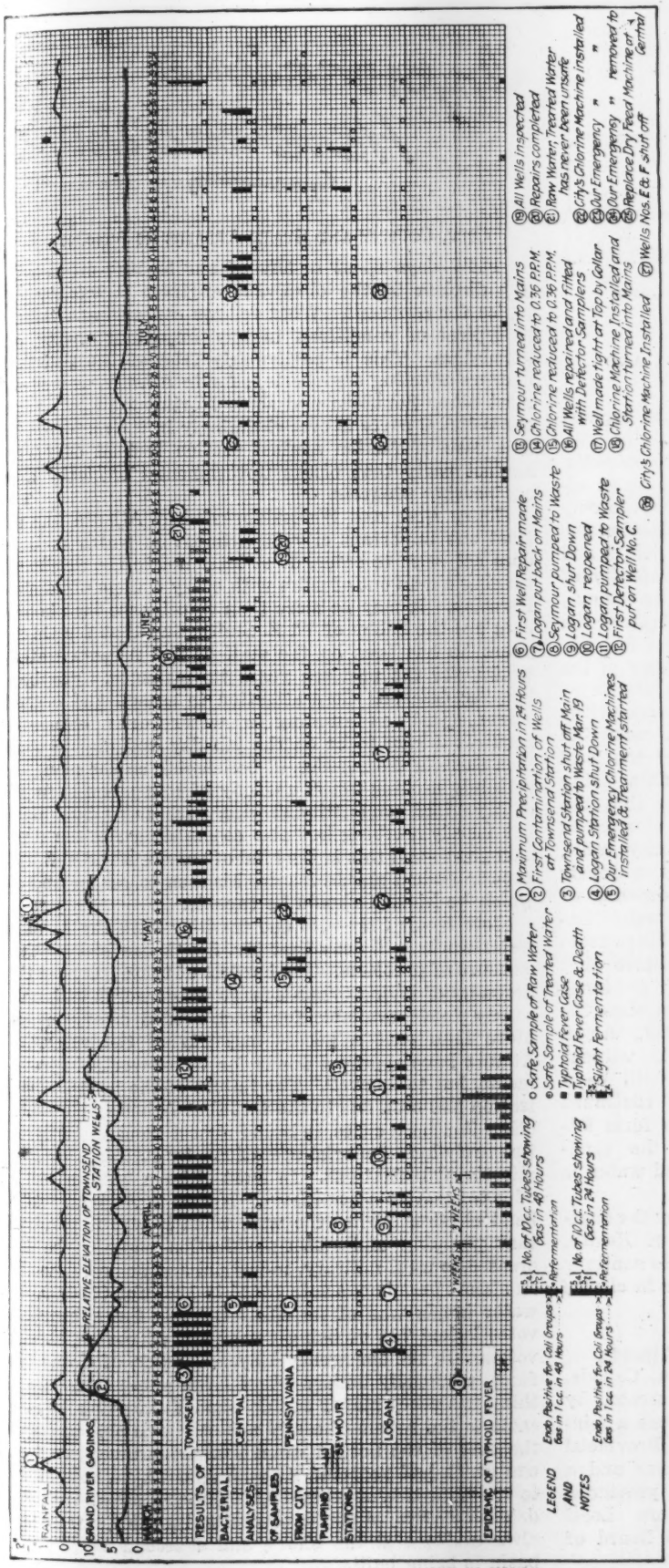
The wells at the Townsend St. station were inspected Mar. 22, and it was found that a plainly audible leak at the top of well *C*, a poorly made and leaky lead joint at well *D*, and a recessed flange set on top of the casing of well *H* were allowing serious leakage of grossly polluted seepage to enter the casings. All the other wells appeared to be tight. The manholes were torn out and the wells repaired as recommended with standard flange couplings wherever possible. One of the original rich-



RELATIONS OF WELLS, RIVER AND SEWER AT TOWNSEND PUMPING STATION

cement mortar joints around the casing and suction line was extended to form the bottom of the old manholes, and although it was 8 in. thick the joint on well *C* leaked badly and there was evidence that several of the others were not tight. Where lead had been used the casing was cut off below the old lead joint and a new 6-in. lead joint was poured and calked. Water-tight concrete manholes were ordered built at each of these wells.

After these repairs were completed the samples from the Townsend St. station continued unsafe. The pump

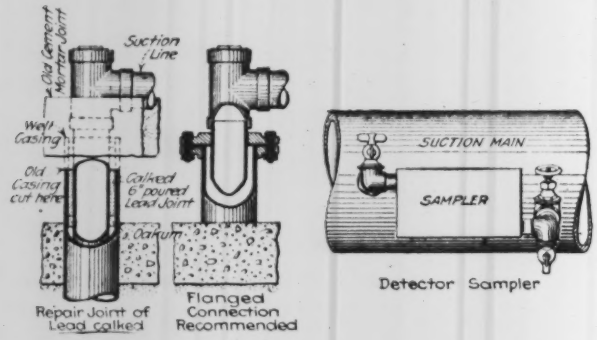

RAINFALL
GRAND RIVER GAUGINGS
RELATIVE ELEVATION OF TOWNSEND STATION WELLS
MARCH
APRIL
MAY
JUNE
RESULTS OF BACTERIAL ANALYSES OF SAMPLES FROM CITY PUMPING STATIONS
TOWNSEND
CENTRAL
PENNSYLVANIA
SEYMOUR
LOGAN
EPIDEMIC OF TYPHOID FEVER
LEGEND AND NOTES
No. of 10 c.c. Tubes showing Gas in 48 Hours
Fermentation
Ends Positive for Coli Groups Gas in 1 c.c. in 48 Hours
No. of 10 c.c. Tubes showing Gas in 24 Hours
Ends Positive for Coli Groups Gas in 1 c.c. in 24 Hours
Safe Sample of Raw Water
Safe Sample of Treated Water
Typhoid Fever Case
Typhoid Fever Case & Death
Slight Fermentation
1 Maximum Precipitation in 24 Hours
2 First Contamination of Wells at Townsend Station
3 Townsend Station shut off Main and pumped to Waste May 19
4 Logan Station shut Down
5 Our Emergency Chlorine Machines installed & Treatment started
6 First Well Repair made
7 Logan put back on Mains
8 Seymour pumped to Waste
9 Logan shut Down
10 Logan reopened
11 Logan pumped to Waste
12 First Detector Sampler put on Well No. C
13 Seymour turned into Mains
14 Chlorine reduced to 0.36 P.P.M.
15 Chlorine reduced to 0.36 P.P.M.
16 All Wells repaired and fitted with Detector Samplers
17 Well made tight at Top by Collar
18 Chlorine Machine Installed and Station turned into Mains
19 All Wells Inspected
20 Repairs completed
21 Raw Water Treated Water has never been unsafe
22 City's Chlorine Machine Installed
23 Our Emergency " "
24 Our Emergency " " removed to
25 Replace Dry Feed Machine at Station
26 Wells Nos. E & F shut off
27 City's Chlorine Machine Installed

WATER-SUPPLY CONDITIONS IN RELATION TO TYPHOID EPIDEMIC

and suction line were so badly contaminated that samples from each well pumped separately failed to reveal which of the wells were still being polluted. To accomplish this, the writer designed a detector sampler and installed it on the suction line at each of these wells, as shown. With this device a representative sample under actual operating conditions could be taken at any time. The main valves on the sampler were left open, allowing constant circulation while the wells were being pumped. To obtain a sample both valves were closed, the top pet-cock was opened, and the sample was drained from the bottom pet-cock. A patent on the sampler has been applied for, and if this is granted steps will be taken to put the device on the market, as it has a wide application and usefulness that will be recognized by engineers and waterworks and public health officials.

After a series of 75 samples had been taken from the samplers on these wells, the State Department of Health, June 14, ordered wells *E* and *F* cut off and plugged. A decided improvement in the quality of the water from the station followed immediately, as is shown by the chart, proving the efficency of the samplers under their first test. Samplers on each well of a group will detect contamination of a well which might not show under normal conditions in an analysis of a sample from the pump discharge, on account of the dilution received in the total quantity. Wells whose contamination is thus detected can be repaired or cut off before the amount of pollution becomes serious enough to cause an epidemic.

Over 3,000 cases of dysentery and an epidemic of 82 cases of typhoid fever followed by 11 deaths justified our ordering the City of Lansing to install chlorine machines in four of the five stations. Treatment has been continuous since the installation, but the dose has been decreased as the quality of the raw water has been improved by repairs. Chlorination may be discontinued if a long series of tests proves that any of these stations is delivering sterile water, but the machines will always be ready for immediate use in case of contamination of wells or for disinfecting dead-ends where stagnant water allows bacterial growth. Our recommendations have been based on the results of analyses of more than 800 samples of water collected by the writer during this investigation. The chart shows graphically the state laboratory reports of samples from the pumping

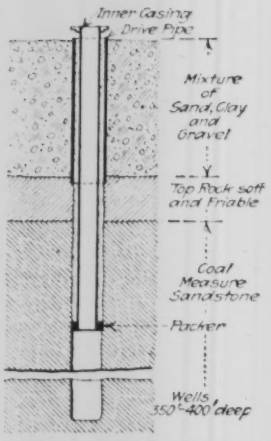


WELL-HEAD CONNECTIONS AS REPAIRED, AND SAMPLING DEVICE ON SUCTION MAIN

stations, also rainfall, river gagings and the typhoid fever epidemic history.

Lansing's experience is a very emphatic contradiction of the old deduction that because "the water always has been good" it always will be good. It is only a question of time before most well supplies become unsafe, on account of (1) deterioration of joints and piping; (2) pumpage in excess of normal capacity of the wells causing fissures at the bottom of the casings, and (3) careless abandonment of wells penetrating the same water-bearing strata.

The typhoid fever spot map and the discovery of the leakage at joints at the Townsend St. station prove that the first of the conditions mentioned above was the principal cause of the local epidemic. The data being accumulated show that the second condition also exists in some of the city wells, making necessary a repair as shown in the drawing of the double-cased well. Examinations of drillings from the top rock indicate that the insertion of an inner casing is advisable when the well is being drilled. Abandonment of wells without careful plugging will be a larger factor, as continued pumping tends to form lateral fissures in the sandstone, and polluted water is thus drawn down the old wells.



INNER CASING OF WELL SET IN CEMENT

The investigations at Lansing were made by the engineering division of the State Department of Health, under the direction of Edward D. Rich, state sanitary engineer, the writer being assistant engineer in charge of the work.

Provincial Health Administration in Alberta

Health affairs in the Province of Alberta, Canada, are in charge of a Department of Health, created by the latest session of the legislature. There are a minister of health, a deputy minister and a Provincial Board of Health consisting of two physicians and a sanitary engineer. In addition, there are a provincial sanitary engineer and five sanitary inspectors. Local boards of health are under the Provisional Board of Health.

Impressions Here and There

City, County and State Affairs in Atlanta

A FEW days spent in any of our leading cities will disclose to the observant engineer a variety of topics for comment. What follows concerning Atlanta is typical of conditions in any important center of population. This is particularly true of the political matters affecting engineering, for in Atlanta, as well as most other Southern and some Northern cities where one political party is overwhelmingly in the majority, it is a case of faction against faction instead of party against party that blocks Governmental efficiency and engineering progress.

Honey Bees and Water-Works—But Atlanta has at least one important city department in which politics does not seem to enter, or at least not to the extent of turning a man out of office with every change of administration. It may be more than coincidence that honey bees are the hobby of W. Z. Smith, and that for thirty years he has been on the staff of the Atlanta water-works, for the past ten years its manager. For bee-keeping demands close attention in season and out of season, just as running a water-works efficiently requires a man to be on the job day and night. And then there is the reaction of beekeeping on the man, for certainly nothing excels a colony of bees as an example of organized community service, with every individual not merely working but also coöperating for the common good—and this is the kind of service a water-works superintendent should inspire his men to render and of which he himself should be capable.

State Binds City—No one familiar with the Atlanta water-works will deny that Mr. Smith has had his full measure of problems. The hardest of these has been the necessity of trying to run a large water-works with only scanty funds available for much-needed enlargements. More than once a goodly majority of the voters of Atlanta have approved bonds for water-works improvements, but to no avail. The failure of the bond authorization has been due to the fact that Atlanta, like many other Southern cities, is bound almost hand and foot, in its purely local financial operations, by statutory or constitutional limitations. In most cities a bare majority of votes carries a bond issue. Not so in Atlanta. At a bond election during the war, when it was imperative that pumping and water-purification capacity be increased to meet military, industrial and domestic needs, an almost unanimous vote (8444 to 128) for $500,000 of water bonds was of no effect because the affirmative votes lacked 784 of being two-thirds of the registered voters. In the emergency Mayor Candler, of Coca-Cola fame, personally underwrote a large pump contract—a thing not every mayor can do—and Fulton County also came to the rescue of a city not only well able to stand the cost of the needed water-works improvements but one which had recorded its willingness by a vote of 66 to 1. With this aid, two 30,000,000-gal. steam-turbine-driven centrifugal pumps are being installed, one at the river and one at the filters, and a second coagulation basin is being built.

Might not a larger measure of home rule well be extended by the legislature to Atlanta and to other Georgia cities as well, since most, if not all, of them appear to be in the same boat?

How much more serious the Atlanta water problems of the past few years would have been were not the city in the 100% metered class it is easy to imagine.

Some of the Atlanta water filters still in use were among the earliest mechanical filters built—Hyatt, dating from 1887. The plant has been enlarged several times since then, and the burden on the filters has been reduced by providing both coagulating basins and combined storage and settling reservoirs, the latter giving 7 to 10 days' sedimentation. This lightening of the filter burden is in line with what has been done elsewhere since the early days of mechanical filters when, with the confidence begotten of a promising innovation, it was first sought to make the filter do all the work. But is the virtual elimination of baffling from the new coagulation basin in line with the development of the art? The new basin has only one low cross-wall a short distance from the mixing chamber; and that appears to have been designed chiefly to bring into play the sediment hoppers—hoppers like those in a few sewage-settling basins, but rarely, if ever, used heretofore in water treatment. Knowledge of how the sediment hoppers will work in practice will be awaited with interest.

Snails Eat Algae on Sewage Beds—Besides being one of the earliest municipalities to use mechanical filters, Atlanta was the first large American city to put in Imhoff tanks for sewage treatment. The way these are working calls for no comment, but on looking across the sprinkling filters on can but speculate on whether the revolving ventilating cowls are paying capital charges. However this may be, snails on these sprinkling filters are certainly earning their "board and keep." Algæ growths were beginning to cause anxiety at the Peachtree Creek plant last spring, when Walter D. Marshall, assistant engineer in charge of sewage-works, noticed that they had disappeared in spots. Examination showed innumerable snails on the stones at the top of the beds. As the snails increased and spread the algæ disappeared. A single stone affords lodging place for as many as twenty snails, from the size of a pinhead up to ¼ in. in diameter. This suggests how little is yet known as to the entire range of biological forces that play, and that might be made to play, a part in sewage disposal.

Misadventures in Garbage Incineration—Like a score or so of other American cities that have gone to considerable expense to build high-temperature refuse destructors on the assumption that the heat from the destructors would yield a revenue to the city, Atlanta is not yet utilizing its destructor steam commercially. In fact, a strenuous effort was made to prevent the acceptance of the destructor from its builders. This seems to have been local political by-play, too common in American cities on a change in administration. The court decided that the destructor as built fulfilled the terms of the contract. The plant has been operated since May, 1916, but the heat has not been utilized. A year or so ago a contract was negotiated with the local electric company to buy current generated from the steam raised by the destructor, but the bond issue proposed to build the necessary generating plant, like the water bonds already noted, failed to receive the statutory majority, although the project had been indorsed by the city board of consulting engineers. Continued failure to utilize the steam from a destructor designed for that purpose is the more notable because the city has scrapped three different makes of furnaces, completed in 1894, 1900 and 1904. Why Atlanta should have had this series of misadventures in garbage incineration seems worthy of local investigation, as also why Atlanta burdens its board of health with the operation of a garbage destructor—a function now generally recognized as pertaining to the engineering or public-works department of a city. Is there some connection between the two?

A Unique Board Sidetracked—Atlanta stands almost alone among cities in having a local board of consulting engineers. But, thanks again to factional politics, the board does the city little good just now, for since the latest change in administration the consulting engineers are not consulted. If they were, perhaps there would be no ground for the remark of a local engineer that an expenditure of 15c. a yard for oiling wood-block pavements in Atlanta the past summer would have protected pavements which at present prices would cost several dollars a yard. Lacking this, the implication was, the wood blocks shrank in dry weather and let water under them and were lifted when rain came. Nothing was said to indicate that the failure to oil the wood blocks could be laid to the engineering department of the city. It may therefore be assumed that it rests with the governing body, or perchance ties in with lack of home-rule control of municipal affairs, which seems to leave Atlanta in a helpless state, from which its chief relief appears to come from the county.

County Aids City—Aside from its apparent ability and willingness to help out the City of Atlanta, Fulton County is notable because it has no bonded indebtedness and also on account of its extensive use of convict labor—facts which may explain the ability of the county to help the city. This help includes contributions of both money and labor. Apparently, the county is freer of legislative control than the city. Certainly, counties in other parts of the country could not, without getting into the courts, thus divert their funds and working forces for the benefit of a city. It should be noted, however, that counties in the South have larger powers than in most states of the north. It is also true that a large part of the funds of Fulton County are provided by the taxpayers of Atlanta, but scores of other cities pay nearly all the taxes of the counties in which they are located, without receiving any such help in return.

Convicts Build Vibrolithic Pavements

Convict labor on county work appears to be common in Georgia, and Fulton County seems to be its leading exponent. Convicts who have given trouble elsewhere are sent here with confidence. "Firm and fair" is the motto of the foremen and armed guards in charge of the convicts. No favoritism is shown. Some of the convicts, long-termers, have gained much experience in roadmaking. The convicts are mustered out from camp at sunrise and back at sunset. The actual working time is about nine hours a day. In poor weather, with little or no work done, sustenance costs make convict work expensive, says William Hansell, Jr., superintendent of public work of Fulton County. But, he thinks that on the whole it is less costly than contract work. Mr. Hansell might have added that the convicts have to be fed anyway, and are better off at work than idle.

As an illustration of what convicts can do, it may be mentioned that the major part of the work on a stretch of vibrolithic pavement just outside Atlanta was being done by convicts late in 1919—that is, the material was being moved to the concrete mixer, spread or smoothed with rakes after having been spouted to place, strewn with stone from a shovel and covered with boards ready for the vibrator, all by the convicts. These also removed the boards after vibration and smoothed or floated the surface with a piece of wood at the end of a long pole. The vibrators (gasoline engines mounted on rollers), however, were not handled by the convicts. Mr. Hansell thinks that when he began using the vibrators he got better pavements than without them, but he doubts the advantage of vibration now that he is able to produce better concrete than before he had his present amount of experience.

Highway Project Engineers—Atlanta engineers had their share of helping out in a recent emergency due to lack of state funds to meet Federal-aid appropriations—that is, they became "highway project engineers" by first signing a contract with the State Highway Department to become its employees, subject to its direction, and then, on being assigned to a specific county, entered into a contract with the county to do the engineering work on a Federal-aid project, for stipulated fees. The contract with the state was incorporated in the one with the county. After trial, the scheme does not appear to be popular with Atlanta engineers. Having to put up bonds, to advance money, to wait for pay, to be tied with red tape, and the lowness of the fees, are objections urged by one project engineer or another; but perhaps working on fee and waiting for pay were the most serious objections. Whether the project-engineer plan will be continued, or an engineering force created under the reorganized State Highway Department, is unknown at this writing. A seeming advantage of the present plan is that it may insure a higher grade of engineers to represent the counties than can be expected, as a rule, where county commissioners choose their own engineers; especially if, as is commonly true, they restrict their choice to county residents. Another possible advantage is that by combining in one the engineering representative of the state and of the county there are two instead of three engineers responsible for each Federal-aid project.

Society Action and Opportunity—It will be apparent from all the foregoing observations that city, county and state problems afford ample scope for the engineers of Atlanta, individually and collectively, to take a hand in civic affairs. This they seem inclined to do. At one of the monthly luncheons of the local members of the American Society of Civil Engineers a committee was appointed to confer with H. L. Collier, chief of construction of the City of Atlanta (really city engineer) on the question whether the three sewage-works of the city are being so operated as to assure full return on the investment. Attention might also well be given by Atlanta engineers to such other matters as why the city has scrapped three refuse incinerators and whether it is really losing anything by not utilizing the heat from the fourth; whether the garbage should not be fed to hogs instead of burned; whether or not garbage disposal should be under the Board of Health; whether or not the various city departments dealing with engineering matters have funds enough to meet the needs of the city efficiently; the financial and other relations of the city and county as regards public works; and the need of more home rule for Georgia cities. Suggesting these questions is easy enough to an outsider, but one does not need to be in Atlanta long to learn of various slumbering fires of factional politics that the discussion of some of these questions would cause to flash up. All the more reason, then, for engineers to take a vigorous part in Atlanta's civic affairs. They should lead in placing city engineering matters above factional politics. Finally, there should be brought to the attention of the engineers of Atlanta the desirability of an amendment to the city charter that will change the present irrational method of choosing the chief of construction, as the city engineer is called. He is now elected by popular vote—a practice that should not exist as regards any technical administrative official, city or state.

ATLANTA, GA.

Sheet Asphalt—Ideas On Suitability of Varying Bases—Costs

Washington's Half Century of Experience Indicates that Concrete Base Is Necessary as a Matter of Economy

BY F. S. BESSON

Captain, Corps of Engineers, U. S. A., on Duty With the Engineer Department, District of Columbia

EXPERIENCE with pavements in the District of Columbia indicates that a concrete base is necessary as a matter of economy. There are two types of surfaces for which such a base is used. One includes stone, brick and wood paving blocks, and the other continuous bituminous surfaces. In regard to the first type, material manufacturers, city and state engineers and Federal officials agree universally, and it is unexpected when similar agreement relative to bituminous wearing surfaces is not found.

However, statements are current that asphaltic surfaces over bituminous and old macadam bases not only cost less for construction, but also cost less for maintenance than when cement concrete bases are used. The reason for this greater economy is stated to be due to the fact that surface pushing and cracking are at their maximum when concrete base is used. The history of Washington's streets does not support this theory, as may be seen from a study of the pavements laid at various periods.

DIVISION INTO DIFFERENT PERIODS AND TYPES

These pavements may be divided into particular types laid at various periods in an attempt to get the most economical streets for the city. The first period is that from 1871 to 1878, during which time more than 700,000 yd. of bituminous pavements were constructed under a half dozen or more different patents. These pavements, including their surface courses, ran from 8 to 14 in. in depth. The base courses of some of them were so saturated with bituminous cement as to form a dense rigid concrete which gave many years of excellent service. A few such examples, though they have been resurfaced and much repaired, are still in existence. The bitumen in the base appears as bright and fresh as though just laid. These good pavements were the exceptions, and as a rule the bases of this first period had no stability. The cost of those that gave promise of reasonable service was as great as and often greater than if cement concrete had been

used; and when the first Board of Commissioners was established in 1878 it abandoned the use of bituminous bases in favor of concrete. In the first concrete bases, imported and American natural cements with very lean proportions, about 1 : 4 : 10, were used under the primitive methods of 35 years ago. Nevertheless, good results were obtained, and since that time, with the exceptions noted herein, sheet asphalt on a 6-in. cement-concrete base has been the standard asphalt pavement of Washington.

Ten years after the first period, or about 1888, determined efforts were made to obtain a base at less cost than the standard, and recourse was once more had to bituminous mixtures, using the standard asphalt top for wearing surface. During the 6-year period from 1888 to 1893, 500,000 sq.yd. of pavement was laid with this base. The cost of concrete made with portland cement became less and less each year, and in 1893 reached a sufficiently low level to permit the commissioners to grasp the opportunity to abandon definitely the bituminous base. There have been later short periods during which departures have been made from the standard pavement, but these have but emphasized the hazard of using old macadam and bituminous bases. Though there are examples that have given undoubted serviceability, many others have not, due to the unreliability of assumptions as to traffic, climate, subsoil and drainage conditions. Portland-cement concrete best meets the requirements of a foundation which is dependent upon these conditions.

Annual Cost of Standard Sheet Asphalt Pavements

Data pertaining to the 3,000,000 sq.yd. of Washington's standard sheet asphalt on 1 : 3 : 7 concrete base show that this standard pavement may be depended upon to require an average of only 2c. per square yard per year for maintenance throughout a life of 25 years. This cost per square yard may be divided up as follows: First six yars, 0.0c.; years 7 to 11 inclusive, 0.5c. each; years 12, 13, 14, 15, 16 and 17, respectively, 1.0c., 1.5c., 2.0c., 2.5c., 3.5c. and 3.5c.; years 18 to 25, 4c. per year each. The cost of a pavement is the amount of money that it is necessary to deposit each year as a sinking fund in order to retire construction and maintenance costs at the end of a definite period. With interest at 5%, the following sums deposited annually at compound interest will pay these costs in 25 years: Six cents per year to pay construction cost of $3 per square yard; 15c. per year to pay interest on construction cost; 1.59c. per year to pay equated annual repairs; or a total of 22.59c. per square yard per year. The equated annual repairs are determined by the amount which it is necessary to deposit each year in order to amount at the end of the 25-year period to the total yearly maintenance cost compounded annually during that period.

After lapse of the period for which the life of the pavement is estimated, it is necessary to pay no further money for interest and depreciation annuity for the construction costs, and, instead of equating the annual repairs, it is but necessary to pay annually the cost of the yearly repairs. In other words, the annual cost of a pavement which has been in use for a longer period than the estimated life is only the amount of money spent yearly on the annual repair. The excellent service given by Washington's standard pavements during the period of superage, in comparison with bituminous-base pavements, is evidence concerning the real worth of the concrete bases.

Annual Cost of Bituminous Base Sheet Asphalt Pavements

Examination of data relative to those streets constructed with bituminous macadam base during the period 1888-1893, and an inspection of such of them as now exist, show the disavantages of using other than a rigid base for pavements subject to heavy traffic. Of the original 500,000 sq.yd. more than half have been replaced by standard asphalt pavement with 6-in. concrete base. Much of that remaining is permitted to exist only because it is on minor streets, subject to practically no heavy traffic. In many spots the base has become so defective that, when passed over by a truck, the pavement flexes as though it were thin ice. This bending of the 3-in. sheet-asphalt surface cracks it into small lozenge-shaped patches, and the pavement rapidly goes to pieces. The remaining 237,058 sq.yd. of this bituminous-base pavement now has an average age of 28 years and has averaged 4c. per square yard per year for maintenance. It must be realized that this is far from a representative average for the entire group of bituminous-base pavements in question, as those now in existence are the cream of the original group.

Preservation of Present Stone Roads

The greatest problem of road economics is how to preserve and utilize the large mileage of present stone roads. It is false economy to apply such utilization to heavily traveled streets and cover old macadam with sheet asphalt, the cost of which can be amortized satisfactorily only in the case of a pavement with long life, small maintenance cost and small traffic-transportation cost. In the use of old macadam roads as foundations, consideration must be given to the work necessary to bring the old road to proper grade and cross-section, which often completely destroys the bond of the old road. This bond is considered one of its assets as a foundation. In Washington some examples of asphalt pavements on old macadam bases have cost from 5 to 8c. per square yard per year for maintenance prior to giving 10 years of service. Rapidly increasing maintenance costs indicate early replacement which, however, is often indicated to a greater extent by resultant high transportation costs. Tabulated maintenance costs alone do not give a full history of a pavement. It is impracticable to maintain a pavement properly once it starts going to pieces. The hazard of macadam foundations for heavy traffic is shown by those existing in Washington, which in comparison with the standard asphalt pavement, are most unfavorable investments.

Town-Road Aid in Maine

Maine, at the legislative session which closed recently, passed a law to aid the towns in the maintenance of their roads. To benefit by the law the towns must have had a tax rate of at least 4 mills for road purposes for five years. The state aid amounts to $10 per mile of through or "route" highway per year, based on the four-mill levy. For each additional mill in the tax rate $1 per mile is added; that is, if the tax levy for road work is seven mills, the state will pay the town $13 per year for each mile of "route" highway.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

What Do You Mean, Worth?

Sir—In your issue of Dec. 25 I note the editorial, "What Makes a Record?" in which it is pointed out that dollar statistics today are apt to be deceptive as an interpretation of volume or quantity. The same thought is brought out, though in a lighter vein, by an item in F. P. A.'s column in the New York *Tribune* of Dec. 17. Possibly in view of the dry spell you may find it worth printing:

"The hotels of New York are said to have $5,000,000 worth of liquor on hand, but whether this means that it cost them $5,000,000 or they could sell it—and would—for $5,000,000 is not evident. When a bottle of whisky that cost 95c. is sold at 60c. a drinklet, it makes a difference when you say $5,000,000 worth. What do you mean, worth?" SOBER.

New York City.

[The nom de plume used by our correspondent is, to say the least, open to suspicion. Does the gentleman "protest too much?"—EDITOR.]

Greed and Reason in Construction Work

Sir—Conditions in the building industry are most peculiar, there being throughout the world a woeful lack of buildings of all types, more particularly houses and apartment buildings. In the United States this condition is due to an almost total suspension of so-called non-essential construction work during the war. In consequence of the shortage there is an unprecedented demand for houses and buildings of various types, and there have been varying predictions as to the period of time required before the supply will equal the demand. In all probability it will be several years before the demand is caught up with.

There is, in my judgment, an element of danger in the present situation. I refer now to the policy of business men in general and also labor, to boost prices and wages in the effort to "get theirs while the getting is good." Both labor and materials are unprecedently high; so high in fact, that were it not for the unusual housing problems there would be very little construction work done at present prices. As it is, a great volume of construction work of the speculative type and also many buildings which would be constructed for permanent investment, will be postponed indefinitely. Where the danger lies is in continuing to advance prices on all materials needed in construction work, for, while it is true that labor costs have advanced terrifically during the past two or three years, it is equally true that many advances which have been made in building materials and all other lines are unreasonable and unjustifiable. Unless business men in general call a halt on the ever-soaring prices, we will soon see a period of depression instead of the several years of splendid business which should be ours by reason of the existing conditions.

Despite the shortage and the unusual demand it is possible to halt the present building boom and when once checked it will be difficult to get under way again. Is it not better to be satisfied with a fair profit and have a prosperous condition throughout the building industry for several years than to have a comparatively short period of exorbitant profits and then a long period of depression? I believe it is.

Wise handling of the situation by manufacturers and dealers in building materials will insure for the industry a prosperous condition for several years, even though many other lines of business should be depressed in the near future, as has been predicted by statisticians and students of economics.

There is another angle which should be considered and that concerns the rights of the public which, after all, are greater than the interests of any individual or group of men. In line with the foregoing, the Northwestern Expanded Metal Co. has squarely placed itself on record as being opposed to further advances of any nature whatsoever. On the contrary we believe prices should be reduced where it is at all possible to do so without real injury to the individual business. I may add that we reduced prices of our products during the forepart of the present year and as we have made several wage advances since that time, we would be justified in increasing prices accordingly; but we have not done so, believing it the better policy to hold prices at their present level.

In my opinion, no business is justified in further advancing prices unless absolutely necessary to save the business from actual loss. This is not an original or novel idea, but is simply the application of common sense to the present situation, and both capital and labor will do well to take heed. By united action and a general adoption of this policy it will speedily bring the country back to a more normal condition and will tend to curb the spirit of unrest which permeates every walk of life. It will also postpone, if not actually avoid, the period of depression which we are headed for.

HOWARD W. FOOTE,
President, Northwestern Expanded Metal Co.
Chicago, Ill.

[The same plea for a unity of unselfish effort was voiced editorially in *Engineering-News Record* in the issue of Feb. 6, 1919, p. 267, under the caption "Are You Doing Your Share to Start Construction?"—EDITOR.]

Engineering and Adventure

Sir—I like very much Professor MacDonald's paper "Engineering and Adventure," in your issue of Jan. 1. Will you let me tell a tale that may further illumine the professor's thought and point a warning?

Seven years ago I was put at the head of an engineering enterprise. We were a new organization, competing with a matured institution—the recognized leader in the field. We gathered together a group of young men whose chief asset was enthusiasm. We set out to get the scalp of the older organization—to get it by doing a better job, by giving a product more nearly meeting the demands of the field. We got the adventure that Professor MacDonald speaks of without going beyond the shadows of New York's skyscrapers. With us the new enterprise was a game. We studied each of the team-mates carefully and impressed upon him that his personality had to show in the work of the new organization if he were to find the job worthwhile. We were not playing football, but the speed bursts were com-

parable to those long runs that drive the home crowd crazy at the big game of the season. Month by month we scanned the returns. There was no roaring grandstand to cheer us on, but our satisfaction was just as great when we saw the gap between us and our competitor narrowing. Whether we would have won no one knows. The race was closed by a consolidation, but there is reason to believe that the competitor thought it best to anticipate the inevitable.

So much for the adventure—Professor MacDonold's spirit of adventure. It's great. I'm for it. I believe that a real leader can put it into the most prosaic enterprise—like digging a ditch, or laying pavement base. You know the story of J. Waldo Smith and the New York Board of Water Supply. The flavor of that organization (I was never part of it) will linger till my dying day. There was adventure for you—the adventure of the Catskill Aqueduct—even though senoritas and sage brush were 3,000 miles away.

So much for the adventure. Now for the warning:

I had trained each of my team-mates to the point of view that he was an important man—and he was. We could not have spared a single one. But after the consolidation, with a bigger future opening, two of them seemed to get the idea that they had to have their own way or not play at all. I had petted them too much—and had failed to show them their weaknesses. One man—a hard, faithful worker, effective only under close guidance—finally left, demanding a "big job at big pay," while the other quit in a grouch. They and their teammates had no complaint about salaries. In fact, looking back, I am inclined to think that rapid salary advances were part of their undoing.

Now I'm in a new game. I have inherited a goodly number of tried men and have added some likely youngsters. We're going about this job as the other team did after the old; and, as in the old job, we're going to win—win through the spirit of adventure that Professor MacDonald has exalted in his article. The wine of adventure will quicken our senses, the prospect of victory urge us on.

Adventure? Yes—but meanwhile I'm hoping that I may avoid the earlier mistake and not spoil the team, that I'll be able to develop the best in the men without turning their heads. For obvious reasons, Mr. Editor, you must let me sign myself INCOG.

New York City.

Eccentric Girder Connections

Sir—In your issue of Oct. 16, 1919 (Published Nov. 27, 1919), p. 730, there is an article "Common Errors in Detailing Steelwork for Buildings," by Edward Godfrey. It would appear from a practical analysis of some of the connections shown that Mr. Godfrey's recommendations tend rather to increase than to diminish the error.

Mr. Godfrey says that he has given the matter of failures much study, and has yet to find a single failure where fine theory needs to be brought in to explain the cause. It seems to the writer that had some theory been used in the design the failure would never have occurred. There are practical methods of course, but the so-called "practical designer" has no reason whatever to be "confused" or "disgusted" if his detail will not stand the proper analysis.

Take the case shown in Fig. 1 at (a), p. 731. The column can and should be designed for the combined bending and direct stress, which should not exceed the allowable unit stress as given by column formula. It is not easy to see how it could then bend or fail, and the writer can see no objection whatever to this design.

Referring to Fig. 1 at (b), p. 731, it is not quite clear to what extent the girder is assisting the column in bending; the shear acts at the same point, and the only difference in the two details is that one is attached to the column a little higher than the other. The column should be designed for the bending moment or at least a portion of it. Had the web plate of the girder been extended, forming a part of the column, as shown

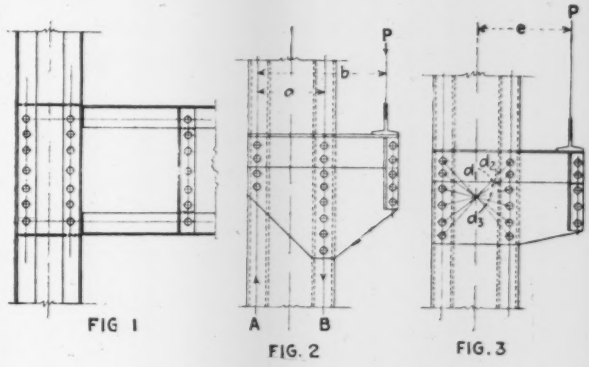


FIG 1 FIG. 2 FIG. 3

in Fig. 1 herewith, then the column could safely be designed for axial compression alone, neglecting any bending moment.

Referring to Fig. 6, p. 732, it is not the writer's intention to go into any fine-spun theory, as Mr. Godfrey suggests, but to give a simple and logical solution of this connection which will give approximately the correct number of rivets in both rows A and B it will require little if any knowledge of the design of steel details, and will be somewhat more economical in both material and shopwork. Mr. Godfrey says: "By the principle of the law of the lever, the vertical force on the row of rivets B is Pb/a. If there are enough rivets in this row there will be more than enough in the row A, as the rivets in the latter row are forced upward." This is quite true, but why not continue by the same principle and find the upward force on the row of rivets A, which is $P(b-a)/a$? This would give a detail as shown in Fig. 2 herewith.

Another simple and practical detail for the same connection is given in Fig. 3. While both solutions give the same number of rivets in the connection, the one which distributes the rivets equally about the center of gravity of the group is to be recommended, as it has some theoretical basis for its adoption. Bearing in mind that the value of a rivet to resist bending moment when located at the center of gravity of the group is zero, also that its value varies as its distance from the center of gravity of the group, and that its moment of resistance varies as the square of this distance, the design is easily worked out on this hypothesis.

C. L. CARMAN,
Assistant Engineer, United States Engineer Office.
New York City.

Rigid Column Connections and Eccentric Load

Sir—In your issue of Oct. 16 you present an article by Edward Godfrey entitled "Common Errors in Detailing Steelwork for Buildings." In Fig. 1 of this article, reproduced herewith as Fig. 1, Mr. Godfrey shows what he has designated as good and bad connections for eccentric loads on columns. In connection with this discussion Mr. Godfrey presents his respects to those members of the engineering profession who make an effort to analyze statically indeterminate structures in these words:

"Ultratheorists will say (referring to *b* of Fig. 1) that by the theory of least work or the theory of relative rigidities the column should be designed for a portion of the bending moment. It is just this sort of theory and theorizing that confuses and disgusts the practical designer, and it is this that the writer believes has no place in structural design."

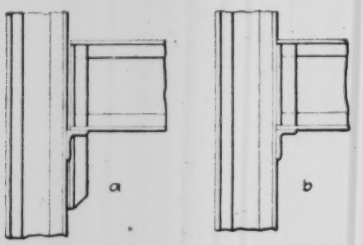


FIG. 1. MR. GODFREY'S ECCENTRIC AND IMPROVED COLUMN CONNECTIONS

With this statement before us let us compare *b*, the so-called good connection, with *a* the so-called bad connection. The fundamental difference between the two connections is that the connection *a* will resist the end shear of the girder, whereas the connection *b* will resist moment as well as shear. Mr. Godfrey states that the effect of the moment connection is to make a portion of the column act the same as part of the girder and the whole may be designed as if the girder extended to the center of the column and as if the columns were loaded centrally.

Fig. 2 herewith shows a loaded girder extending over and resting on the tops of two columns. Because of the deflection of the girder the loads on the columns are eccentric. If the connections between the girder and the columns of Fig. 2 were rigid the gap at B would not be formed; instead, the column would be bent in at the top, thus producing a moment in addition to the moment due to the load being eccentrically applied as at A. This is exactly the condition which exists in connection *b* in Fig. 1. For the connection angles of *b*, Fig. 1, not only exert on the face of the column a shear which acts as an eccentric load but also the connection angles exert a couple on the face of the column and this couple produces on the column a moment having the same sign as the moment due to the shear. In other words, considering the problem from a horse-sense standpoint, ignoring the ultratheorists, it would seem that connections *b* of Fig. 1 might cause a bigger moment in the column than is caused by connection *a*. That is, the so-called good connection may be the bad connection and the so-called bad connection may be the good connection.

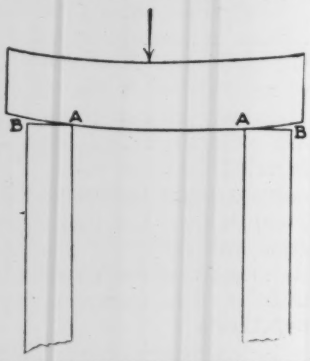


FIG. 2. DEFLECTION OF GIRDER RESTING ON TWO COLUMNS

Now I will ask Mr. Godfrey to overlook his prejudice and I will consult the ultratheorist.

In order to determine the moments in the column it will be necessary to fix geometrical quantities. Consider girder AA of Fig. 3. Then equating moments at A to zero[1] gives

$$2\,EK_{AA}\,\theta_A - \frac{1}{12}\,W\,l + 4\,EK_{AB}\,\theta_A + 4\,EK_{AC}\,\theta_A = 0.$$

The constants are:

$$W = 100{,}000 \text{ lb.}$$

$$l = 240 \text{ in.}$$

$$K_{AA} = \frac{2506}{240} = 10.45 \text{ in.}^3$$

$$K_{AB} = K_{AC} = \frac{2764}{144} = 19.24 \text{ in.}^3$$

Substituting values of the constants in the equation gives $E\,\theta_A = 11{,}460$ lb. per sq.in. Then $M_{AB} = M_{AC} = 4\,EK_{AB}\,\theta_A = 4 \times 19.24 \times 11{,}460 = 884{,}000$ in.-lb.

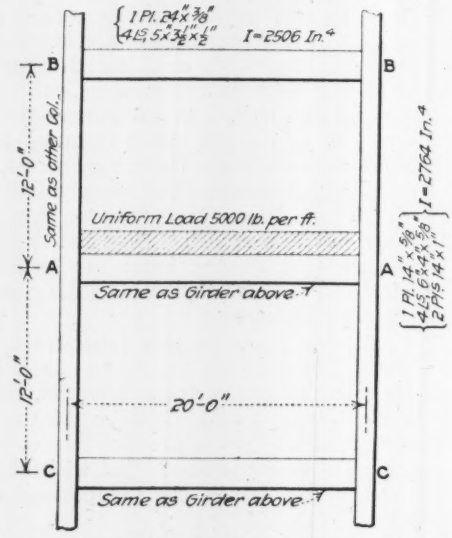


FIG. 3. A CONCRETE CASE OF GIRDERS AND COLUMNS

(This assumes that the columns are fixed at *B* and *C*; if the points B and C are hinged M_{AB} will be 846,000 in.-lb.)

If a connection of the type represented by *a*, Fig. 1, had been used the eccentricity would have been about 9 in. and the moment due to that eccentricity would have been 450,000 in.-lb. In other words, the so-called good connection *b*, designed to reduce the moment in the column, actually increases the moment 96%. Moreover, if the load on the girder had been a single concentrated load at the center the moment in the column with a Type *b* connection would have been 1,326,000 in.-lb., or 295% of the moment in the same column due to the same load if a Type *a* connection had been used.

No! Replacing Connection *a* with Connection *b* will not reduce the moment in a column due to an eccentric load. Neither is it safe to replace the ultratheorist with Mr. Godfrey's so-called "practical designer." What we need is a practical designer who knows his theory.

I have criticized Mr. Godfrey at considerable length

[1] See equation A, p. 20, Bulletin No. 108, Engineering Experiment Station, University of Illinois, by Wilson, Richart and Weiss.

because his error is closely related to a common error among structural designers. Structures are usually designed on the assumption that the connections are hinged whereas the structure is built with rigid connections. A very common opinion is that neglecting the fact that the connections are rigid increases the factor of safety. This is not necessarily true. With a very large number of structures making the connections rigid introduces large secondary stresses which are entirely ignored in the design. Personally, I cannot understand why in a structure that is easy to analyze a stress of only 16,000 lb. per sq.in. is allowable, whereas a stress of 20,000 to 24,000 lb. per sq.in. is allowable in a structure that is hard to analyze. The fact that the stress is a little more difficult to determine does not prevent the stress from entering the structure. The advent of the strain gage has shown that secondary stresses, which many supposed to exist only in the brain of a college professor, actually exist in steel structures.

Even neglecting an unknown overstress of 25% is not the most dangerous result of a partial analysis of stresses. I believe that if the truth were known it would be found that 90% of structural failures have been due to the structure failing in a way that was not even considered in the design. I believe that a more careful analysis of structures, especially of an entirely new type, would cause the most likely method of failure to be discovered.

Stress calculations will always be left to a subordinate. Moreover, horse sense will always be used as the final check of a design. But the horse sense of a man who has computed secondary stresses and, especially of a man who has operated a strain gage, will call for quite a different design than the horse sense of a man who has only considered statically determinate stresses.

W. M. WILSON,
Associate Professor of Structural Engineering,
Urbana, Ill. University of Illinois.

Stopping Track Creepage on Heavy Grades

Sir—In the abstract published in *Engineering News-Record* of Nov. 27-Dec. 4, under the title "Track Creepage Stopped on Heavy Grades of Logging Railroads," some of the plans suggested do not conform to what has been considered good practice on most lines of railroads. "Old timers" can recall the use of rails that were slotted for the purpose of anchoring rails to the ties but with the advent of the modern slotted angle bar splice, the slotting of rails has generally disappeared. On the logging roads with which the writer has had experience, the rail section has been so light that he has never felt justified in reducing the effective section unnecessarily. It should be possible to get a satisfactory anchorage without cutting into the base of the rail at a vital point. Most writers on track and bridge maintenance advocate a careful avoidance of any sort of attachment of rails to bridge decks excepting those necessary to hold the rails down to the ties and to hold them to proper gage and line. Frequent instances of undue straining of bridges have occurred as a result of rigid connections of rails to ties or to stringers. It is generally considered preferable to anchor the rails well at the bridge approaches but to allow them free play longitudinally on the bridges. Even the spiking in angle bar slots or at ends of angle bars is prohibited on many roads.

The following methods are suggested to reduce the creeping of rails on heavy grades: (a) In laying track, see that proper provision is made at each joint for expansion, (b) keep all joints full bolted and nuts drawn up tight, (c) use extra length angle bars, spiking to three ties (through angle bar slots) at each joint, and (d) at such intervals as may be required, substitute a heavy timber "dead man" for the joint tie, (e) in special cases, such as at bridge ends, bolt long, heavy bars to joints, carrying these bars back and spiking to three or more ties. These may be bolted to outside of splices by using extra long bolts. If necessary, several sets of these may be placed at critical points.

Excepting in street railway construction, the writer has never found it feasible to insulate the rail from heat by covering with earth or gravel, though if conditions of traffic, drainage and track maintenance permit, such covering of the rails should assist materially in reducing the tendency of the rails to creep.

New Orleans. A. M. SHAW.

Changes in the Value of the Dollar

Sir—As a contemplation of conditions worse or more extreme than those prevailing at present has a soothing influence on most of us, perhaps you will allow me to comment, with this end in view, on the article appearing in the Nov. 27-Dec. 4 issue, p. 937, on "Changes in the Value of the Dollar." As both statements are obviously quite correct, does it not add unnecessary confusion to the issue to draw any fine distinction between the cheapness of gold (the dollar) and the high price of commodities, both meaning exactly and precisely the same thing? Any argument along this line must necessarily end where it began.

Broadly speaking, there is nothing new and unprecedented, so far as values are concerned, in the present economic period, nor is there apt to be any long-time permanence to these conditions. Your article deals almost exclusively with the symptoms, and not with the disease, or the cause itself.

An article in the November issue of the *World's Work* quotes Adam Smith as follows:

> The discovery of the abundant mines of America reduced, in the 16th century, the value of gold and silver in Europe to about a third of what it had been before. As it cost less labor to bring those metals from the mine to the market, so when they are brought thither they could purchase or command less labor; and this revolution in their value, though perhaps the greatest, is by no means the only one of which history gives some account.

and I further quote from this very able article itself:

> Since Adam Smith's time there have been five major movements in the purchasing power of gold, or in the price of commodities, as we more frequently consider it. For twenty years preceding 1809 there was an upward movement of prices which was entirely wiped out by the decline in the succeeding forty years following the Napoleonic wars. Then began the upward movement, coincident with the discovery of gold in California. This movement culminated after the sharp Civil War advances in this country. Then from the early '70s to 1896 there was a gradual downward movement which resulted in the free-silver agitation of that time. After 1896 gold production began to increase rapidly, due to the commercial application of the cyanide process for its extraction and to the discovery of gold in South Africa, Colorado and Alaska. This was the latest period of advancing prices, the one with which the present generation has had the most experience. It seems to have culminated in the revolution in prices due to the war.

It is further pointed out that since 1915 the gold production of the world has rapidly declined. So far this year over 90% of the gold produced in this country has been used in manufacturing and for purposes other than coinage. With the present known sources of gold, and present methods, this decrease will continue until only those mines will be left producing which could show a profit of at least 50% in 1914. Then the growing scarcity will again produce a relative value sufficient to stimulate production among the higher-priced producers. It is rather generally held that the arbitrary value of the gold standard is its own corrective. This process is now under way, and, as war-time restrictions are now lifted, it is being further helped by the export of some gold, treasury and otherwise.

The foregoing, I believe, may be considered as more or less orthodox. To this might be added the following surmise: Our Federal Reserve system has not had anything like a conclusive peace-time trial, and it seems at least plausible that even without the excessive war demand the vast amount of erstwhile restricted credit which it had to release, if used by the banks in general, would have promoted a cycle of inflation and higher prices in this country. Furthermore, during our participation in the war there was intensive (not to mention what amounted to compulsory) saving. Now we have had a year of intensively extravagant spending from these savings and high wages. A vast amount money has circulated from the sale of bonds. The latest treasury report shows a profit of several millions, due to retiring these bonds, below par.

With the exception of a limited number of monopolies —for instance, diamonds—the marginal factor in the law of supply and demand is infallible, and it requires but the smallest margin of scarcity or surplus in relation to the demand to effect the price greatly. Silver at present sells for a price actually above the coinage value. Iron and steel prices are high and firm, while copper commands a price less than the production cost of some fairly prominent plants.

It might be pertinent to say here that this marginal concept applies with equal force to your professional man. Each year our institutions add to the surplus of average ability. Further apparent injustices in the pay for brain workers in general is augmented by the lack of, and almost impossibility of, organization or union. Human beings may be equalized or unionized with some degree of fairness on a basis of manual labor, but scarcely the vaguest sort of a general value can be assigned to the brain worker, because of no comprehensive basis for a day's work. How could a union wage-scale work out for the "Brotherhood of Technical Journal Editors"? The professional man is still further entangled in a conspiracy known as "ethics," whatever that may be. Even assign for his benefit, if you will, a relation between gold and an index value, and you are still apt to leave him high and fairly dry, under existing conditions.

And now for any consolation that may be derived by a little further light on the statistics under your caption, "What the Statistics Prove." It is asserted . . . "these statistics prove that the cost of living today is higher—the purchasing power of the dollar is *lower* than it has been at any time." The statistics prove this because you have examined them over a very limited period only. In 1864 the Dun index was represented by the figure 312. The highest figure which you give (244.64) lacks just 67.36 points of eclipsing all records. From 1864 there was a decline for 33 years, until 1897 the index stood at 72.

It is further a fact that while our currency will purchase less in this country than for a considerable period heretofore, it will purchase more in some other markets than ever before.

The process of correction is again under way. Less gold is being produced and a large proportion of what is produced is going into the arts. Able minds are working on better methods and labor-saving devices to increase production and cheapen it. Europe will eventually not require so much of our margin, and it will then be up to the sales manager to function normally again, hustling around to dispose of, at lower prices, material on which labor may be willing to work an extra half-hour or so a day, in order to produce it competitively. Then will our professional and fixed salaried men wax very fat and maybe just a little superior once more. Labor's chief concern will be that due to the uncertainty of continuous employment.

R. L. SITES,

New York City. The Brown & Sites Company.

Method of Laying Out Split-Switch Turnout

Sir—Referring to the communication from L. C. Scott, p. 711 of *Engineering News-Record* of Oct. 9, 1919, entitled "Method of Laying Out Split-Switch Turnout":

It seems to me that the method outlined—that of setting up the transit at the point of the switch—is in error, since the lead curve does not begin at this point but at the heel of switch points.

In a modern turnout we have two tangents; that is, the line of switch rail produced and the line of frog rail produced. The only true turnout curve, therefore, is one that will connect heel of switch with toe of frog. For a given frog number, with distances from point of frog to toe of frog and from point of switch to heel of switch, as well as throw of switch, constant, there can be but one true connecting curve. With the various lengths of switch rails and frogs in use no one set of tables can be expected to fit all cases.

Since nearly every railroad has a standard length of switch rail and frog for given frog numbers, it would seem logical to compute the true turnout curve for each number of frog, establishing a standard lead distance for each frog. With this distance (adjusted for economical use of rails without cutting), point of switch and point of frog may be located and, if necessary, points on turnout curve established from measurements from main track rail.

The curve back of the frog has no relation to turnout curve, since the turnout has passed through a frog tangent of not less than 10 feet before reaching heel of frog. Good practice would require an additional frog tangent of at least 10 feet back of the frog proper, and the secondary curve to be sprung from this tangent, the curvature of this secondary curve being less than the turnout curve proper.

I do not believe that a competent trackman would install a turnout with the sharp angles mentioned by Mr. Scott, "stakes or no stakes." While it is true that a large percentage of derailments occur on turnouts, these are due in part to the use of longer and heavier

engines and overloaded cars which cannot take the sharp curvature, but often to defective and dragging equipment catching on switch rods and guard rails.

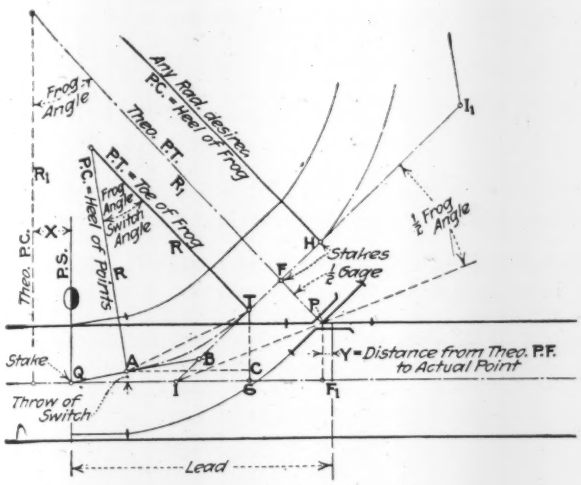
In my opinion, the only curve that needs the attention of the engineer is the curve back of the heel of the frog, and this in all cases should be handled from the frog tangent.

R. L. LONGSHORE.

Montpelier, Ohio.

Sir—Referring to L. C. Scott's letter on p. 711 of *Engineering News-Record*, of Oct. 9, 1919, relative to layouts for split switches:

The accompanying sketch shows the method of making switch layouts employed on the Union Pacific R.R.



LAYOUT FOR SPLIT SWITCH TURNOUT

Solution: Given frog angle, switch angle, dimensions of switch points and frog, and gage of track.

(1) Solve triangle IFP, obtaining IF ($IF = IF_1$) and IT.

(2) Solve triangle ITS, obtaining TS, CS, IS and TC.

(3) Solve triangle ATC, obtaining AC and AT, which is the long chord of a curve having a radius R, and semitangents BT and BA and a central angle equal to the frog angle minus the switch angle.

Lead = length of points + AC + SF_1 + distance from theoretical to actual point of frog.

(QA = length of points).

R_1 = radius of theoretical curve shown by Searles and others in turnout tables.

X = Distance from theoretical SC to point of switch and can be figured if desired.

To stake out:

Set up at I, turn off frog angle, and set stakes at Q_1, F, H, and I_1, etc.

This is the only way in which a simple curve can be obtained from the heel of the points to the toe of the frog with no tangent between points and frog.

I believe that if Mr. Scott will use this method in figuring one of his turnouts it will be clear to him that the length of the lead depends upon the length and angle of the points, and the distance from the toe to the point of the frog as well as the frog number or angle.

If tables of split switches are available based on the same (or approximately the same) lengths of frogs and switches as are being used, results should be satisfactory, provided the curve beyond the frog starts at or beyond the heel of the frog.

V. F. WETMORE.

Omaha.

Sir—Engineers will generally agree, I think, that the method of laying out a split switch turnout advocated by L. C. Scott in your issue of Oct. 9, 1919, p. 711, is preferable to the one advocated by the office engineer he mentions.

It is immaterial what degree of curve is used after leaving the frog, so long as it meets the requirements of the rolling stock used, or the standards of that particular road, since the curve of the turnout ends at the point of the frog, the line from that point being a tangent of at least the length of the frog itself, and can be of any greater amount necessary, the following curve being selected to suit conditions.

My practice has been to locate the point of frog so as to avoid cutting a rail; that is, the distance from the rail joint in the main track to the point of the frog, measured toward the point of switch, being made equal to the length of the frog from the heel to the point. At this point a hub is driven at half gage from the gage side of the nearest rail and outside of the track on the side on which the turnout is to be laid. The transit is set up over this hub, and a foresight taken along the main track parallel to it. An angle equal to the angle of the frog to be used is turned away from the track, and another hub driven on this line at about 10 ft. or more from the first one. From this last hub, the line is run to suit conditions as they may be found. The plus of the first hub, the point of the frog, is usually given as 0 plus the length of the lead of the turnout to be used, which can be taken from any standard book giving tables of this kind.

The location of the switch points can readily be determined by the track foreman from the same tables, or from his standard frog and switch plans, which generally are provided by the engineering department of the road. The plans will show also the ordinates of the lead rail for each different turnout used.

Of course, in congested or restricted locations this plan may have to be modified, as also in cases where turnouts occur on curves.

H. M. KANARR,

Punxsutawney, Penn. Civil and Mining Engineer.

To Control Filter Operation

Control of the operation of water-purification and sewage-treatment plants is now the big task of the Illinois Department of Health, according to Capt. Paul Hansen, chief engineer. On this subject he says: "There are a number of communities in Illinois that have filter plants that are little better than useless, simply because we cannot induce the local authorities to operate them properly. The operation of sewage-treatment plants is even worse than the operation of water purification plants. Fortunately, this does not so intimately affect the public health.

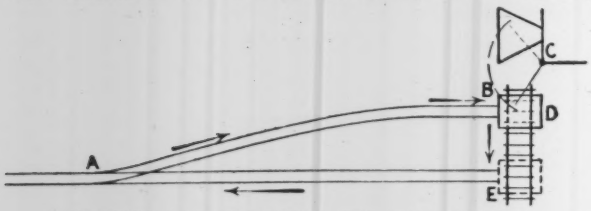
"I have been urging for several years that small communities retain the services of consulting engineers to guide them, in connection with the operation of water-purification and sewage-treatment plants. Such services can be had at a very nominal figure, and will be a decided advantage to both the engineer and the community. The community will benefit by the advice, and the engineer will have an opportunity to learn something of the operation of the plants which he is called upon to design. In the near future, we hope to supervise the operation of a small number of water-purification and sewage-treatment plants, merely as a demonstration of what can be accomplished by such occasional expert control."

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Transfer Table Switches Batch Cars at Mixer

IN PUTTING in concrete base for asphalt pavement in Detroit, Mich., light industrial track is successfully employed for hauling proportioned batches for as short a haul as ¼ mile from stock pile to mixer. To permit quick shifting of loaded and empty cars at the mixer, the arrangement indicated by the diagram has been successful on work performed by W. E. Currie, general contractor, Detroit, Mich. Trains of cars, each carrying two batch boxes are pushed in on switch A B. The batch boxes are picked up and dumped by the mixer crane C. Then the batch car is run onto the transfer car D and shifted to track E A. As the last car is being discharged at the mixer, a second loaded train is pushed onto A B, and the locomotive uncouples and switches back to pick up on A E the empties of the first train. Based on the successful operation of this switch and transfer-car arrangement, a plan is contemplated by which the whole system A B E, including the transfer track, will be mounted on a triangular platform on low wheels, thus forming a portable switch to be moved by a niggerhead on the mixer.

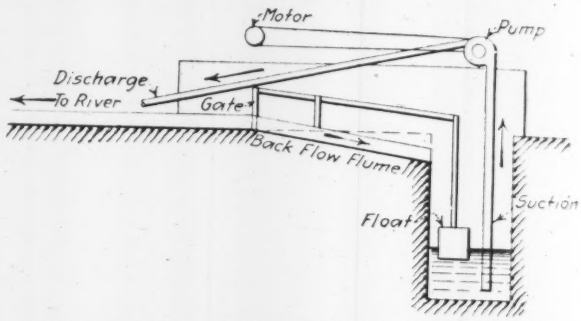


SWITCH AND TRANSFER FOR BATCH CARS

Controlled Bypass to Suction Permits Continuous Pumping

BY means of a simple float and wood gate the pump man handling the water from the trench of the Notus canal inverted siphon on the Boise Project of the U. S. Reclamation Service was able to keep his motor-driven centrifugal pump running continuously without losing suction. Enough water was allowed to drain back into the suction pit through the float-controlled gate to maintain a level varying not more than a foot. The rig consisted of a block of wood for a float attached to an upright connected to one end of a fence board lever with a fulcrum in the center. The other end of the lever raised and lowered a wood gate in a sluice box 12 in. wide, carrying water from the discharge end of the pump back to the suction pit.

CENTRIFUGAL KEPT RUNNING WITH HOMEMADE BYPASS

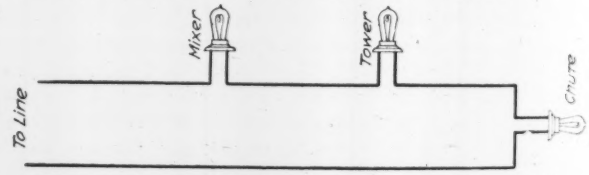


FLOAT CONTROLS DISCHARGE BACK TO SUMP

Signaling Concrete Mixer by Lights

BY E. K. BORCHARD
Philadelphia, Penn.

ON A recent concreting job it was necessary to move delivery chutes frequently, which necessitated holding up the mixer and also the delivery from the discharge hopper at top of the hoist tower. Bells were first used as a means of signaling, but were sometimes not heard or were misunderstood. Signal lights connected in series, as shown in the illustration, proved much better than bells and were foolproof. When the concreting gang wanted to shift chutes, they turned out their light, which in turn automatically extinguished the lights at the tower head and the mixer. Instructions were given not to mix or send down concrete unless the lights burned, so this stopped the supply.



LAYOUT OF SERIES-CONNECTED LIGHTS AT MIXER

When the work was ready to proceed again, the concreting gang turned on their light, which lighted the other two also. By having the light at the end of the chute, the foreman or any of the gang could see at a glance whether concrete was coming, and there was no uncertainty concerning whether the signal had or had not been given.

The lights connected in this way burn dimly unless lower-voltage lamps are used.

Improvised Cableway for Light Bridge Erection

A CABLEWAY suitable for light bridge erection service, and which can be improvised from materials on the job, is illustrated as used by the British Army railway engineers in France. As described by Capt. I. Simson in the *Royal Engineers' Journal*, each pair of sheer legs consisted of two telegraph poles 50 ft. to 56 ft. long with butts about 11½ in. and tips 6 in. in diameter. The feet of each sheer leg were spaced 13 ft. apart, so that a railway truck with material could be run under the legs, and the material be picked off the truck by the lifting tackle. The sheers themselves were about 120 ft. apart. The runner, traveling and lifting tackles, and both back guys, consisted of 3½-in. to 4-in. manila rope. No blocks with more than three sheaves were available at the time. All lashings were of 2-in. rope, while ¾-in. chain was used, in addition, at each crotch, to fasten the blocks of the runner tackle and back guys.

The arrangement of blocks shown had the following advantages: (1) Equal strain in all returns of each back guy and "runner" tackle; (2) easy adjustment for the considerable stretch that took place in all back guys and runner tackle; (3) by paying out on Q (not under load) the strain on the "runner" tackle was reduced to a minimum for heavy loads.

No derrick poles or tackles were required to erect the sheers. The legs were placed opposite their footings, both crotches lying away from the gap. Sheers B was lashed down to the railway track temporarily; while the crotch of sheers A was raised on a crib built up on a railway truck—the crotch thus being 12 ft. or so above rail level—and the feet tied back temporarily to the track. By pulling on the runner tackle in the direction Q1 from the side B of the gap, sheers A was pulled up and its back guys were made fast when A was leaning forward over the gap.

The free end of the runner tackle Q1 was then run over the second pulley of the double block at the crotch of sheers B, and, by pulling in the direction of Q2, sheers B was raised. When also leaning well forward the free end R1 of the back guy for B was made fast, and the free end Q2 of the runner tackle run through the snatch block, at foot of sheers B, in its final direction Q, in which it was made fast. The legs were adjusted for verticality by taking in or paying out on R1 and R2. The runner tackle was adjusted to suit by paying out or taking in Q. The operation of lowering was carried out by practically reversing the above process.

The sheer legs A—on the side of the gap to which material can be brought by rail or road—should be situated as near the edge of the gap as possible consistent with picking up the loads directly, and the running end P of the main fall should be run off on this side of the gap. Sheers B should be situated as far from the edge of the gap as the length of the cordage will allow. The object of this is to get the far end of the bridge near the center of the span. All loads then run down the runner tackle, until at the center of the span they are at their lowest point. If they have to go further than this, the loads must then be pulled up the runner by means of S1. Steel cable for the runner tackle would undoubtedly prove a great improvement.

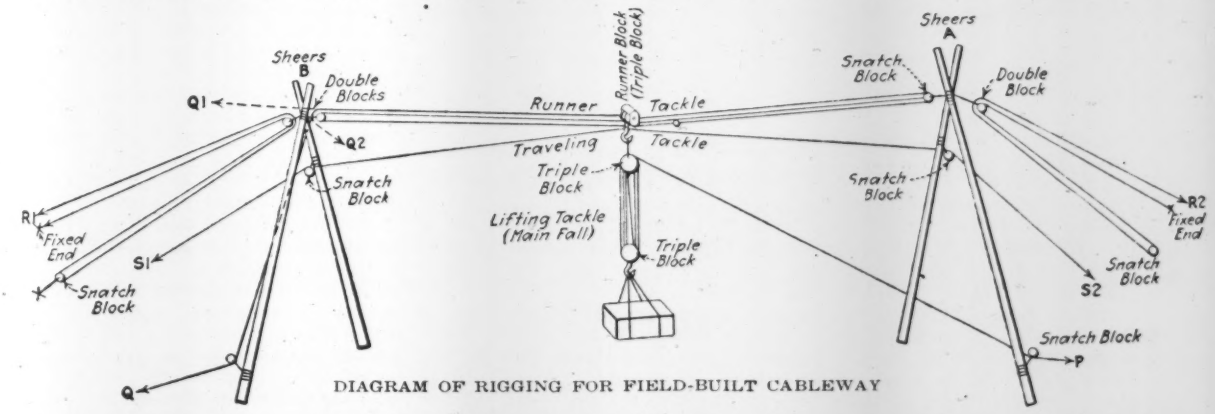
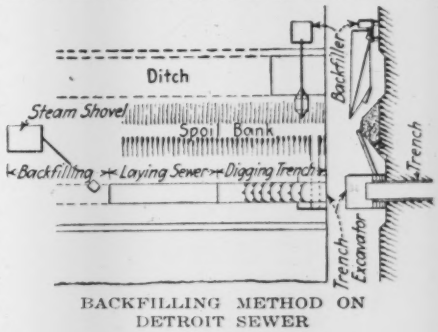


DIAGRAM OF RIGGING FOR FIELD-BUILT CABLEWAY

Ditch Dug to Receive Surplus Excavation From Trench

FACILITY in disposing of surplus excavation from sewer trench is gained by a Detroit contractor in in the manner indicated by the accompanying diagram. A 4-ft. trench about 20 ft. deep, for a 4 x 6 ft. egg-shaped brick sewer, is being dug by a trench excavator in an unpaved street in a sparsely built-up district. The material below the top soil is clay, which cannot be disposed of except by long haul to dumps, as property owners will not use it for grading or allow it to be scattered on their land.



BACKFILLING METHOD ON DETROIT SEWER

Since the volume of excavation displaced by the sewer had in some way to be wasted, the contractor excavated, with a steam shovel, a broad, shallow ditch. The excavation took only the top soil, which was loaded into wagons and which could be readily disposed of on nearby and often on adjacent lots. The volume of the ditch was approximately the volume of sewer displacement. A power backfiller taking from the spoil bank filled the ditch. Then the remainder of the spoil required to refill the trench was filled back by steam shovel. With the machine outfit indicated, about 35 ft. per day of 4 x 6-ft. brick sewer was averaged.

NEWS OF THE WEEK

New York, January 8, 1920

Progress on Muscle Shoals Dam Construction

One of the Largest Masonry Dams in the World Being Built by Federal Government on Tennessee

Construction is well under way on the so-called Wilson Dam, being built by the Government at Muscle Shoals on the Tennessee River at Florence, Ala., near Government nitrate plant No. 2, which was completed toward the end of the war. This dam, with its accompanying locks, is part of a project which has been before Congress for many years, but which was not authorized until the need of power for the nitrate plant could be urged in its favor. There was, however, no possibility of developing the power in time for its use in the nitrate plant, so steam power had to be provided for the war operation of that plant.

The dam will be about 96 ft. high from bedrock to pool level and over 4,000 ft. long, and will have nearly 1,000,000 cu.yd. of masonry, which will place it among the largest in volume ever built. Eventually there will be at the south end of the dam enough turbines to generate 300,000 to 375,000 hp. At present four 30,000-hp. turbines will be installed. The bulk of the power so generated is to be supplied to the nitrate plant. At the north end of the dam there is a flight of locks, each 60 ft. wide, with 300 ft. available length. These, with the completion of dams 1 and 3 below and above, will constitute the navigation project.

Construction work on the dam is in the preparatory stage. About ten

(*Concluded on page* 108)

Consular Service Wants "Retired Engineers" With "Independent Means"

A consular examination has been set for Jan. 19. Officials of the Consular Bureau at Washington, D. C., have expressed a desire that retired engineers should take this examination so as to be on the eligible list for appointments requiring men with special training where that training would be particularly valuable to the United States.

The fact that younger men are not attracted by consular salaries has led to the conclusion that the parsimony of Congress in that respect can be met only by inducing men with private means to engage in the work.

[*Comment on this request for "retired engineers" will be found in the editorial columns of this issue.*—EDITOR.]

Chief of Engineers Appointment Delayed for President's Opinion

(*Washington Correspondence*)

The Secretary of War continues to decline to reply to inquiries as to when he expects to recommend a new Chief of Engineers, U. S. A. Some weeks ago it was understood that he regards the appointment of the Chief of Engineers of such importance that he will not take action until he has discussed the matter with the President. A few days ago Mr. Baker stated that he had not seen the President since his (Mr. Baker's) return from Panama. From this statement it is inferred that no recommendation from the Secretary of War may be expected pending its discussion with the President.

Canadian Model Registration Bill Is Drafted

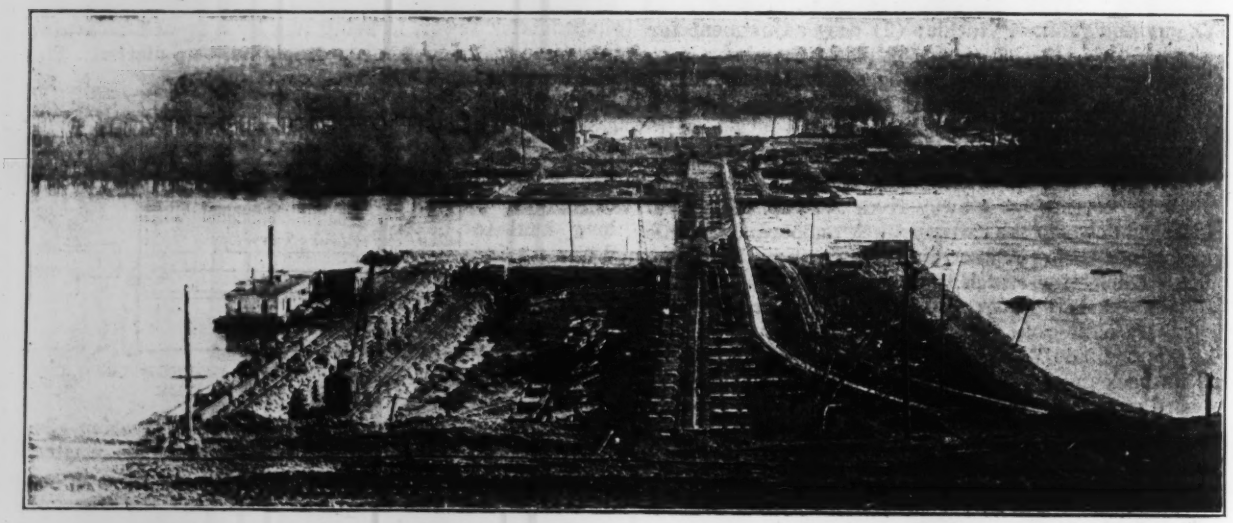
Act Provides Medium for Regulation of All Professions Not Now Controlled

The draft of a comprehensive, professional registration bill to serve in Canada as model legislation, to be introduced into the various provincial legislatures, has been presented in a report of the Joint Committee of Technical Organizations to the several Canadian technical societies which the committee served. The draft provides for examination and registration in all branches of the technical professions and all other professions, with the specific exception of law, medicine, dentistry and surveying as long as their regulation is continued by existing laws.

The report recites that the two essential factors involved in creating the "status of the engineer" are, in their proper sequence, "recognition" and "remuneration." It says that the degree of the latter is proportionate to that of the former, which in turn is limited by the value of engineering service to the community at large. Publicity and legislation are given as the proper means of obtaining recognition, the former to be largely the result of engineer participation in public affairs. Publicity is called the offensive weapon and legislation the defensive.

The report says, in part: "The primary function of all legislation is the protection of the public. If this principle is rigidly applied to any engineering legislation that may be framed, it will be found that the engineer has

(*Concluded on page* 110)



LOOKING SOUTH OVER CONSTRUCTION OPERATION ON WILSON DAM AT MUSCLE SHOALS, ALA.

Commonwealth Drydock Opened After Battleship Trial

The Commonwealth Drydock at Boston, the largest of its type on this side of the Atlantic has been opened for service, the first vessel to be docked being the U.S.S. Virginia which was floated into position at 9.50 a.m. Dec. 22 to test the dock's operation. The unwatering was accomplished by means of three electric pumps in about two hours. The capacity of the dock is 55,000,000 gal.

The Commonwealth Drydock was started three years ago under order of a special act of the Massachusetts Legislature. It was constructed under the supervision of the directors of the Port of Boston and later by the Waterways Commission of Massachusetts. It was flooded for the first time June 11, 1919. The drydock was purchased by the Government for $4,100,000 under agreement that the dock should be turned over completed in every respect. The cost to the state will be in excess of $3,000,000.

The structure is 1,170 ft. in length and 114 ft., 9 in. in depth. The depth over the sill at low water is 35 ft. The largest ship that can be accommodated is one of 1,150 ft. length, 115 ft. beam and 45 ft. draft. The foundations of the drydock rest on solid rock. The approaches are dredged to a depth of 37 ft. Two wet docks adjacent for berthing ships are planned by the Navy Department.

Discuss Highway Transport at Motor Truck Show

A series of highway transport conferences is attracting not only dealers and manufacturers of motor vehicles, but all those interested in truck transportation at the 8th Coast Artillery Armory, New York City. The conferences, being held in connection with the national motor truck show, began Monday afternoon, Jan. 5, and will continue until Saturday afternoon, Jan. 10.

Afternoon sessions are being devoted chiefly to subjects of most importance to those engaged in the motor truck business and the evening sessions to owners, operators, shippers and all others interested in truck operation and in the economics of highway transport. In the evening sessions separate subjects are being discussed, including the development in transportation, increase in motor haulage efficiency, rural motor express, aids to motor truck afficiency, and motor truck as compared with railroad freighting. Saturday afternoon three engineers, prominently identified with highway construction, will speak. They, and the subjects assigned them, are: Arthur H. Blanchard, professor in charge of highway engineering, University of Michigan, "Relation of Roads to Operating Cost"; H. Eltinge Breed, consulting engineer, New York City, "Progress in Highway Improvement"; and F. G. Thompson, State Highway Engineer, New Jersey, "Constructing Roads for Motor Truck Traffic."

Another Award of Contract for Passaic Valley Outfall Tunnel

After being twice abandoned by contractors, the construction of the New York Bay outfall tunnel of the Passaic Valley sewer was again contracted for Dec. 20. The Passaic Valley Sewerage Commission let a contract for the work to the Foundation Co. on a cost-plus contract estimated to involve a cost of $1,500,000. Bids had been asked on both lump-sum and cost-plus bases.

The legal position of cost-plus bidding under the state laws requiring competitive bidding for public work was in doubt for a time. It was decided by the commission's counsel that if the work to be let were new work, lump-sum bidding would be necessary, but that the present contract is an exception as it is a reletting of an abandoned contract. It is expected that the award will be attacked in court.

$50,000,000 Gift to Increase Salaries of Educators

Bringing the total of his philanthropic gifts to an estimated figure of half a billion, John D. Rockefeller has added to his former benefactions a gift of $100,000,000, which is the largest recorded single philanthropy. Half of the $100,000,000 is to be devoted to creating a higher degree of compensation for educators in colleges and universities. The other half will be devoted to medical research throughout the world. Its use will be directed by the Rockefeller Foundation.

The General Education Board, created by Rockefeller in 1902 and since given $52,000,000 for educational purposes, will direct the expenditure of the new $50,000,000 Christmas gift to college educators. Plans for following out that course will be decided upon at the Board's meeting in February.

The memorandum transferring the $50,000,000 to the care of the General Education Board reads as follows: "The attention of the American public has recently been drawn to the urgent and immediate necessity of providing more adequate salaries to members of the teaching profession. It is of the highest importance that those intrusted with the education of youth and the increase of knowledge should not be led to abandon their calling by reason of financial pressure or to cling to it amid discouragement due to financial limitations. It is of equal importance to our future welfare and progress that able and aspiring young men and women should not for similar reasons be deterred from devoting their lives to teaching.

"While this gift is made for the general purposes of the board, I should cordially indorse a decision to use the principal as well as the income as promptly and as largely as may seem wise for the purpose of co-operating with the higher institutions of learning in raising sums specifically devoted to the increase of teachers' salaries."

Program of Am. So. C. E. Annual Meeting Is Issued

The program for the sixty-seventh annual meeting of the American Society of Civil Engineers, to occur in the Engineering Societies Building, New York, Jan. 21 and 22, prescribes one day of solid business and one day of excursions with the two evenings given over to social entertainment. The feature of the business sessions, in which will take place the presenting of annual and special committee reports, the election of officers and appointments to the nominating committee, will be the discussion of the Development Committee's report. It is expected that the discussion of this report, which recommends comprehensive national organization of all engineers, will extend well toward the end of the afternoon of the twenty-first. The business session will be interrupted from 1 to 2:30 p.m. for the service of luncheon in the building to the members of the society.

At 9 p.m. a reception to the president will be given in the board room of the society followed by dancing to begin at 9:30. Supper will be served from 11 p.m.

The second day of the meeting will be devoted to an inspection of the Port of Embarkation of the United States Army at Hoboken, and of the Brooklyn Navy Yard. After the excursions there will be an informal smoker in the Engineering Societies Building at 8:30 p.m.

The committee in charge of the arrangements for the two days' meeting has the following members: Lewis D. Rights, chairman; Charles Gilman, George L. Lucas, Francis Mason and Charles Warren Hunt.

Model License Law Distributed to Elicit Discussion

Copies of the report of Engineering Council's Committee on Licensing, including the committee's model license law, have been mailed to engineers in all parts of the country for the purpose of drawing out discussion to guide Council in its consideration of the law.

The model law, an abstract of which was published in *Engineering News-Record* dated Oct. 16, p. 746, was framed to regulate the practice of engineers, architects, and land surveyors. It is the result of fourteen months of study and discussion by the committee of fifteen prominent engineer members, representing thirteen states and nine branches of engineering practice.

Not ex-Commissioner Carlisle

In *Engineering News-Record*, Dec. 25, 1919, a news story, p. 1079, concerning the road conference held at Albany credited certain statements to ex-Commissioner John N. Carlisle, which should have been attributed to ex-Commissioner Edwin Duffey.

Railway Officials Protest Senate Excess Earnings Provisions

The National Association of Railway Executives has submitted an additional memorandum to the Conference Committee of Congress, now engaged in adjusting the differences of the Esch and Cummins railroad bills, protesting against legislation limiting the earnings of strong companies and making the excess available to weaker lines. The memorandum questions the constitutionality of such legislation.

The recent conference of the heads of railway unions, called by Samuel Gompers, president of the American Federation of Labor, at the same time made public resolutions in favor of extending Government control for two years and against anti-strike legislation.

At this writing, the House and Senate conferees have deferred definite action on the principal points of difference of the two bills. Some minor points have been considered, including the car service sections and agreement has been reached on Government supervision of car distribution.

Meetings of the Association of Railway Executives are being held in Washington in regard to railroad legislation and changes necessary in reverting to private control. It was announced Jan. 5 that the Association favors the continuance of some features of operation under Federal control and has agreed upon the adoption of a rule for distributing cars, continuation of the system of operating statistics established by the Railroad Administration and the present method of collecting transportation charges.

Purdue's Annual Road School To Cover 18 Highway Subjects

Purdue University's sixth annual road school, scheduled for Jan. 27-29, 1920, will afford 18 lectures, on as many phases of highway work, to the state, county, and municipal road superintendents, engineers and contractors of Indiana. The highway subjects covered by the course are to be presented in the form of addresses by selected authorities and followed by discussion.

The attendance of Indiana highway men at this road school in past years varied between 100 and 150, according to George E. Martin, associate professor of highway engineering at Purdue, who believes this year's attendance will considerably exceed the larger figure. On the first night of the course the county surveyors', the county highway superintendents', and the highway contractors' associations of the state will hold their annual meetings.

The subjects and speakers for the course are: "The Indiana State Highway Commission," by L. H. Wright, director of the commission; "State Highway Construction," by H. K. Bishop, chief engineer of the commission; "Hauling Highway Materials," by a speaker not yet announced; "Gravel Roads," by T. R. Agg, professor of highway engineering, Iowa State College; "The Jog in the Road," by E. T. Minton, county surveyor, Tippecanoe County; "The Development of Concrete Roads," by C. D. Franks, district engineer, Portland Cement Association; "The Real Issue in Our Highway Problem," by H. E. Bilger, consulting engineer, Monmouth Stone Co.; "Highway Bridges," by William J. Titus, bridge engineer, Indiana State Highway Commission; "The Relation of the Bonding Company to Highway Work," by a representative of the Lion Bonding & Surety Co.; "Asphaltic-Macadam and Asphaltic-Concrete Pavements," by Arthur H. Blanchard, professor of highway engineering, University of Michigan; "Federal Aid in Indiana," by R. E. Toms, senior highway engineer, Bureau of Public Roads; "Demonstration of Testing of Road Materials," by R. B. Crepps, instructor in Purdue University; "Highway Lessons of the World War," by Prof. George E. Martin, Purdue University; "Construction and Maintenance of Bituminous-Macadam Roads," by Walter Buehler of the Barrett Co.; "The Work of the United States Weather Bureau in Reporting Road Conditions," by J. H. Armington of the bureau; "State Road Maintenance," by A. H. Hinkle, chief maintenance engineer, Indiana State Highway Commission; "The Development of Brick Roads," by Clarke Mandigo, consulting engineer, Western Paving-Brick Manufacturers' Association; "The Administration of the Highway Laws," by a representative of the State Board of Accounts.

Alaska Railway Staff Reorganized

Recent reorganization of the Alaska Government Ry. creates two grand divisions: The southern division, with offices at Anchorage, extends from Seward to Broad Pass, 315 miles, and includes all branch lines as well as the operation of the mines in the Matanuska coal fields; the northern division, with offices at Nenana, extends from Broad Pass to Fairbanks, 152 miles, and includes also the narrow-gage Tenana Valley Ry. Col. F. Mears is chairman and chief engineer of the Alaskan Engineering Commission, which is building and operating the railways. William Gerig, assistant chief engineer, is in charge of the southern division; Frederick D. Browne is engineer in charge of the northern division. Officers of the southern division include the following: F. A. Hansen, engineer of maintenance and construction; T. W. Secrest, assistant engineer of maintenance and construction; G. G. Jones, superintendent of construction; James Hanahan, assistant superintendent of track (Anchorage to end of track); Dan Leech, assistant superintendent of construction (on work north of end of track). The officers of the entire system include W. J. H. Fogelstrom, bridge engineer; Sumner Smith, resident mining engineer, and H. P. Warren, engineer in charge of construction supplies.

Progress on Muscle Shoals Dam Construction

(*Concluded from page* 106)

miles of railroad have been built. The first of six cofferdams was unwatered in August, 1919, and the rock has been largely removed from the excavation for the cutoff wall along the heel of the dam. A construction bridge, with concrete piers, and track level above ordinary flood heights, is being built upon the apron of the dam. About two-thirds of the total volume of 10,000 cu.yd. of concrete in the piers has been placed. This bridge will carry four standard-gage tracks and will handle all supplies and material going to the dam. On a fifth and wider track will be mounted seven 10-ton traveling tower derricks, with 90-ft. booms, which will lift the concrete in skips from the cars and place it in the dam. With these derricks in operation by next spring, it is planned to place 2,000 yd. of concrete per day.

In order to provide the aggregate for the concrete, a dredging fleet is being assembled at Buck Island, nine miles below Florence. Two suction dredges will work at a bar of excellent sand and gravel, which will be screened and washed, and then towed upstream in barges. The last two or three miles' haul will be by rail to the three mixing plants. The largest plant, located on Jackson's Island in mid-stream, is equipped with two 4-yd. mixers; the other two each have two 2-yd. mixers.

Work on the south side of the river at the power-house site has just fairly commenced. A railroad connecting the nitrate plant with the abutment is nearly completed. Three additional traveling tower derricks will handle the concrete for this section of the dam.

The work is being prosecuted with hired labor, and the growing pay-roll now numbers 4,000 men. A construction camp, with facilities to house and mess about half this number, has been completed on the north bank, three miles from Florence, while housing facilities at Nitrate Plant No. 2 are available on the other side. The construction is under the immediate direction of the United States District Engineer, Lieutenant-Colonel Lytle Brown, Corps of Engineers, U. S. A. Of his assistants, Major S. C. Godfrey, Corps of Engineers, U. S. A., is in charge of Administration and Supply, Assistant Engineer D. A. Watt of the Engineering Division, and Assistant Engineers Joseph Wright and J. S. Butler of Construction Divisions 1 and 2 (north side and south side).

Robert W. Hunt Gives Fund for Award for Prize Paper

To assist in making membership in the Western Society of Engineers useful and hence attractive to the younger men of the profession, the Robert W. Hunt Award of $250 will be established for the best paper contributed to the proceedings of the society each

year on any subject pertaining to the manufacture or treatment of iron or steel products. For this purpose Captain Hunt has placed $5,000 in trust in a Chicago bank.

While detailed conditions of the award are not yet available, it is known, in general, that the member must not be over 30 years of age or a member of the faculty of an educational institution. Should the judges consider no paper submitted in any year worthy that year's award, it is to go to St. Luke's Hospital, and if the society shall fail to make an award for five consecutive years the securities are to be turned over to the hospital.

Prospects Brighter for Staten Island Piers

One step further in the complicated procedure apparently necessary to bring about the construction of a terminal pier in New York City was made on Dec. 30 when the Board of Aldermen authorized an additional appropriation which brings the total authorization for piers at Stapleton, Staten Island, up to $14,563,032. These piers have been under discussion for about a year. They lie along the east shore of Staten Island just inside the Narrows, between two private dock terminals. As first contemplated by the City Department of Docks they were to be of the type common in New York City; that is, fairly narrow with a pier shed completely covering the pier. Later, criticisms of this type led the department to change the design of two of the piers at least, so that they will be over 200 ft. wide with the shed only covering the middle of the pier, leaving marginal spaces where freight-handling machinery may travel.

The comptroller of the City of New York refused to permit the authorization of the bonds for the piers until the Department of Docks had executed leases for them. Accordingly the department has procured leases for thirteen piers at a rate of revenue to the city of 7½ per cent on the investment, leaving one pier for open wharfage. Following the receipt of the dock leases by the Board of Estimate, the procedure now is for it to authorize the issuance of special revenue bonds. As soon as the bond issue is authorized the Department of Docks may proceed with the letting of contracts.

Engineer Corps to Prepare Aërial Route Maps

The Secretary of War has directed that the Corps of Engineers will be responsible for the preparation and production of aërial route maps for the use of the Air Service. The Engineer Corps is to be guided in such work by the technical requirements of the Air Service, and the latter is responsible for securing and furnishing such aërial data as may be needed. The Secretary's orders require conferences of the two services for the purpose of working out principles and methods of producing aërial route maps.

Railroad Swingbridge Damaged by Colliding Vessel

(By telegraph)

Traffic on the electrified division of the Southern Pacific R.R. at Oakland, Cal., was blocked on Jan. 6 by the effects of a peculiar accident. A lumber schooner ran into the railroad's 334-ft. swing span across the entrance to Oakland Harbor while the bridge was being closed. The collision locked bridge and vessel together, with the span partly resting on the bow of the schooner. The lower chord of the bridge was damaged. As the tidal rise is about 8 ft. emergency measures to decrease the lifting effect of the schooner were resorted to. A car of rails was loaded onto the bow of the ship, and the span was securely anchored to the center pier with chains.

Will Develop Coos Bay as Rail and Water Terminal

The Port of Coos Bay Commission, Marshfield, Ore., at a special meeting recently voted unanimously to construct and operate a terminal dock to provide a means of handling large freight shipments and to develop further Coos Bay as a rail and water shipping terminal.

In adopting the resolution it was decided that a suction dredge for clearing the channels of the various inlets and for maintaining the inner channel should be provided for in the bond issue covering the cost of the dock. It was estimated that $250,000 will be sufficient to pay for the new dock and the dredge. A special election will be called in Marshfield to vote the bonds.

Secretary Sengstacken of the Port of Coos Bay Commission has instructed James Polhemus and John D. Goss, engineers, to present the project to the Rivers and Harbors Committee of Congress and to the United States district engineer.

Agricultural Engineers Discuss Farming Problems

Civil and mechanical engineering and architecture all came within the scope of the annual meeting of the American Society of Agricultural Engineers, held in Chicago on Dec. 29-31, 1919. Land reclamation and drainage, soil erosion, farm sanitation, isolated water supply and the engineering aspect of stump removal to clear land for cultivation were among the subjects presented, mainly by professors of agricultural colleges. The paper on water supply, however, was prepared by L. C. Landis of the Milwaukee Air Power Pump Co., and related to a pneumatic pressure system for a supply from wells. Dynamometer tests on plows and farm machinery, outlined by F. W. Duffee, University of Wisconsin, suggested possible advantages of such tests on excavators and wagons employed in construction work. Other papers dealt with tractors, farm buildings, the application of power for lighting and for stationary and moving machinery. Strong emphasis on the necessity of applying machinery to farm work, both to compensate for labor shortage and to increase production, was placed by F. W. Ives, Ohio State University. The officers for 1920 include the following: President, F. N. G. Kranich, Hyatt Roller Bearing Co., Chicago; secretary, J. B. Davidson, Iowa State College, Ames, Iowa.

To Make Snow Surveys in Sierras

Snow surveys covering the entire length of the Sierra Nevada range are to be made for the purpose of determining the water-supply available from the snow fields and of perfecting a system of stream forecasting and control in the interests of irrigation, flood control and river navigation. This work will be done by co-operative action of the States of Nevada and California, the former represented by Prof. J. E. Church, Jr., of the University of Nevada, and the latter by Maj. Paul M. Norboe, assistant state engineer of California. Snow surveys of this kind, with Professor Church's work in Nevada, were described in *Engineering News-Record* of Oct. 23, 1919, p. 766.

Am. Soc. C. E. Has Highway Committee

The American Society of Civil Engineers has appointed, through its Board of Direction, a special Highway Committee composed of H. Eltinge Breed, George W. Tillson and A. B. Fletcher. This committee will keep in touch with the development of the Government's plan for the construction and financing of national highways and will advise the society from time to time of these plans and of the activities of the Government through the submission of periodic reports and critical reviews.

General Staff to Supervise Army Map-Making and Surveys

According to an announcement issued Dec. 23 by the War Department, the General Staff will assume supervision of all surveying and mapping activities charged to the department. The Secretary of War has directed that the Military Intelligence Division of the General Staff will decide all questions pertaining to the procurement, reproduction and issue of maps.

The Chief of Engineers by the Secretary's order is designated as the custodian of all military maps based on surveys executed by agencies of the Government and intended for quantity distribution, including survey data relating thereto. He is also charged with the quantity distribution of such maps to the Army, in accordance with tables of issue prepared by the General Staff. The order further prescribes that, based upon requirements announced by the Military Intelligence Division of the General Staff, the Chief of Engineers will prepare programs for survey and map work, which, upon approval of the Chief of Staff, he will carry into effect.

Canadian Model Registration Bill Is Drafted

(*Concluded from page* 106)

received his full measure of protection, not as an engineer, but as a part of the body politic. All that engineers as a class are entitled to is some effective means of protecting their professional reputation and prestige. Legislation can certainly be framed to meet this end, and so framed as to be for, and not at the expense of, the public weal. Anything beyond this must be defined as 'class legislation,' which, in the final analysis, does not protect but stigmatizes, and would ultimately force the engineer into the position of having to protect his legislation instead of having his legislation protect him. Legislation is 'popular' legislation or 'class' legislation according to whether administrative control of registration and the issue of license is vested in the government or in a council or board appointed by the engineers themselves. The former has far the better chance of becoming law."

The draft submitted by the Joint Committee of Technical Organizations includes two pieces of legislation, partaking somewhat of the character of the Illinois and Michigan registration acts. The first covers the general principle and provides for the second. The general act makes provision for the framing and passage of a separate subsidiary act by and for any, or every, professional or vocational class. A description of the general act was presented thus:

Administrative Agency — The measure would create a Department of Registration under the jurisdiction of the Minister of Education and the office of Director of Registration.

Functions of Department of Registration — (a) To administer and enforce laws relating to the regulation of specific professions and technical occupations, and to formulate rules and regulations for administering the same and for the fair and impartial examination of candidates for registration.

(b) To establish and control the standard of preliminary education necessary for admission to training schools, colleges and universities.

(c) To provide, on appeal, for a re-examination of candidates and for rehearings in the case of action to revoke a license or certificate where it appears that justice has not been done.

Specific Legislation—Specific legislation for the regulation of any particular profession, technical occupation or branch thereof may be introduced (a) on the initiative of the Minister of Education, should he consider such procedure necessary in the public interest; or, (b) by request, through the Minister of Education, of a majority of the persons engaged in such professions, technical occupation, or branch thereof.

Certificates and Licenses—To be issued by the Department of Registration.

Exemptions—The provisions of this act shall not be enforcible in respect to the practice of law, medicine, dentistry and surveying as long as the laws now regulating these professions and occupations continue in force.

THE SUBSIDIARY MEASURE

Assuming that the general act as drafted would, by reason of its generality, require a minimum of amendment in the future, the committee drew up a specific subsidiary act covering the professional branch, mechanical engineering, as a model. The general act is to be called Part 1, and successive acts appended for each professional branch or vocation are to be called Part 2, Part 3, etc. Following is presented a description of such a subsidiary or ancillary act, as drafted by the committee:

Title—An Act to Regulate the Practice of ..... and to provide for the registration of .....

Short Title—"The ..... Registration Act."

Administration Agency — Under the general direction of and appointed by, the Department of Registration, a Board of Examiners, one of whom shall be a professor or associate professor of ..... in the University of ....., and four other members, who shall be ..... of recognized standing, who have had not less than ten years of bona fide experience in the practice of ....., and who have resided continuously in the Province of ..... not less than five years.

Functions of the Board—(a) To receive applications for registration, and at their discretion accept those which properly come under the classifications they are delegated to examine, and to reject or refer elsewhere such applications as do not; (b) conduct hearings on matters relating to the revocation of, or refusal to renew, licenses or certificates, and at their discretion to revoke or refuse to renew the same; (c) establish regulations and rules or procedure for the proper administration of the law; (d) examine into and fix if necessary the standard of personal qualifications of applicants.

Reciprocal Registration — Provision to be made for registration of practitioners from foregin countries or other provinces.

Public Works — Provision making it obligatory that construction and maintenance work on provincial and municipal works be handled by qualified registrants under this act, in so far as it applies.

New Jersey Highway Employees Hold Banquet

Employees of the New Jersey State Highway Department held their first annual banquet Dec. 30 at the Hotel Miller in Trenton. Many of the 700 employees, including both those connected with the engineering and clerical forces, attended. Edward E. Reed, assistant state highway engineer, was toastmaster.

New Manhattan Public Service Appointments Made

In accordance with his announced standards for choosing his staff members—ability and experience in city government—Henry H. Curran, since Jan. 1 President of the Borough of Manhattan, New York City, has made three new appointments and retained two officials in the Public Works and the Highways Departments.

Clarence H. Fay is now Commissioner of Public Works. His salary is $7,200 a year. Mr. Fay was a Deputy Fire Commissioner in the Mitchel Administration. The new Assistant Commissioner of Public Works is John S. Shea, former sheriff of New York County. His salary is $6,000 a year. President Curran's Superintendent of Buildings, Rudolph P. Miller, whose salary is now $7,200, began his services in the city government in 1895 as a building inspector. From 1910 to 1914 Mr. Miller was Superintendent of Buildings in the Borough president's office during President McAneny's term. In 1914 and 1915 he was retained by the Board of Aldermen to revise the building code.

The Borough President has retained in office Amos Schaeffer as Consulting Engineer of the Borough and Clifford M. Pickney, Chief Engineer of Highways. Mr. Schaeffer has been in the city's service for the past twenty years. His salary is $7,200. Mr. Pickney, whose salary is $6,120 a year, has served the city for fifteen years.

Extension Engineering Courses Aided by Colorado Society

Extension courses in engineering subjects under the auspices of the Colorado Society of Engineers are to be given in Denver by the University of Colorado. The tentative plan contemplates the formation of separate classes of fifteen or more men for the study of each of the following subjects: "Reinforced Concrete," "Engineering Mathematics," and "Handbook Engineering." The classes are to be conducted on different nights of the week so that the student may take one or more of the subjects. The tuition (required to meet the expenses of the instructor) will be $8 for a four months' course in each of the subjects offered. Other subjects may be taken up under the plan if the required minimum of fifteen students is found.

Honor Colonel Hodge

In the minutes of the New York State Public Service Commission and of the Transit Construction Commission there has been included a resolution adopted by the respective commissioners, Lewis Nixon and John H. Delaney, in a recent joint sitting which expresses the regret of the two commissions in the death of Colonel Henry Wilson Hodge, and their sympathy to his bereaved family. Colonel Hodge had been a member of the Public Service Commission. An appreciation of his ability as an engineer, his services

to the State of New York and his distinguished services to the Government of the United States as an engineer officer in France was also expressed in the resolution.

Civil Service Examinations

New Jersey. Deputy chief engineer, Department of Streets and Public Improvements, $6,000 per year, Jan. 28. File applications with State Civil Service Commission at Trenton.

New York State. Assistant sanitary engineer, State Department of Health, $2,000 per year (with possible increase to $2,400), Jan. 24. Apply to State Civil Service Commission at Albany before Jan. 20. Application forms for this examination will not be sent out after Jan. 12.

New York State. Engineering draftsman, $1500 to $1800 per year, Jan. 24.

New York State. Junior assistant engineer, grade 1, Office of State Engineer and Highway Department, $1620 to $1860 per year, Jan. 24.

New York State. Junior assistant engineer, grade 2, Office of State Engineer and Highway Department, $1980 to $2280 per year, Jan. 25.

United States

For United States civil service examination, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Fire-prevention engineer, office of Director of Purchase and Storage, War Department, duty throughout United States, $2500 to $4000 per year, Jan. 13. Application should be filed before that date.

ENGINEERING SOCIETIES

The Engineers' Club of Minneapolis met in the Main Engineering Building, University of Minnesota, Dec. 15 to hear a description of the construction of the St. Paul Union Depot given by W. C. Armstrong, chief engineer of the work. Mr. Armstrong's address was illustrated by lantern slides. The designs for the St. Paul Union Depot were described in *Engineering News-Record*, June 7, 1917, p. 486.

The Northwestern Association of Members of the American Society of Civil Engineers, in its regular bimonthly meeting in Minneapolis, Dec. 19 discussed the report of the parent society's Development Committee. The members present were concerned principally with that part of the committee's report proposing a comprehensive national organization of all engineers and allied technical professions. While no official action was taken by the association the trend of the discussion was against representation from every local engineering society as making a too unwieldy national organization. Since no substitute method of representation could be decided upon action was postponed until Jan. 6. The members present were constituted a committee to thoroughly study the report and present a written discussion at the Jan. 6 meeting.

Calendar

Annual Meetings

BRIDGE BUILDERS' & STRUCTURAL SOCIETY, 50 Church St., New York City; Jan. 16, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS, 29 W. 39th St., New York City; Jan. 21-22, New York City.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA; 111 W. Washington St., Chicago; Jan. 21-23, Chicago.

ENGINEERING INSTITUTE OF CANADA; General Secretary, Fraser S. Keith, 176 Mansfield St., Montreal; Jan. 27-29, Montreal.

AMERICAN ROAD BUILDERS' ASSOCIATION, 150 Nassau St., New York City; Feb. 9-13, Louisville, Ky.

AMERICAN WOOD-PRESERVERS' ASSOCIATION; Secretary-Treasurer, F. J. Angier, Mt. Royal Station, Baltimore; Feb. 10-12, Chicago.

AMERICAN CONCRETE PIPE ASSOCIATION; 210 South La Salle St., Chicago; Feb. 20-21, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION; 1426 Manhattan Bldg., Chicago; March 16-18, Chicago.

The Indianapolis-Lafayette Section of the American Institute of Electrical Engineers went on record at its meeting in Indianapolis, Dec. 19, as favoring a return to the daylight-saving plan. The sentiment of the meeting was expressed in the form of a resolution.

"Modern Railroad Wire Systems" was the title of an address presented by John L. Niesse, telephone and telegraph engineer of the Big Four railroad.

The Western Society of Engineers was addressed on Dec. 22 by Walter Buehler on the latest developments in the use of wood block paving. Special points were the treatment methods to reduce bleeding to a minimum and the method of laying blocks on smooth concrete with only a slight coat of pitch.

The Engineers Club of Kansas City is voting on an amendment to its constitution which will make it the Kansas City Chapter of the A.A.E. At a meeting held Dec. 13, those attending considered and approved such an amendment and recommended it for the approval by vote of all members. A ballot and a copy of the amended constitution were mailed to all members on the 19th, with a letter advising that the polls would close 30 days thereafter. It is the intent of the new constitution and its by-laws that the club shall thereby lose none of its present powers of self-determination, but shall gain from the A.A.E. in national matters.

PERSONAL NOTES

MYRON E. FULLER has resigned from the American International Shipbuilding Corp., Hog Island, Pa., to resume his work as assistant engineer with Fuller & McClintock, consulting engineers, New York City.

E. W. PITTMAN, formerly chief engineer of the John Eichleay, Jr., Co., has been appointed general manager of the Dravo Contracting Co.'s engineering works department, Pittsburgh.

J. W. LEDOUX, consulting engineer of Philadelphia, has resigned as chief engineer of the American Pipe & Construction Co., in order to devote his entire time to his consulting practice. The severance of his connection with that company dates from Jan. 1, 1920. Mr. Ledoux's specialties are waterworks, valuation, arbitration, rate cases, and water-power development.

HARRY N. JENKS has resigned his position as Assistant Engineer on the California State Board of Health to accept an appointment as Special Assistant Engineer, Filtration Division, City of Sacramento, Cal.

J. LEWIS has resigned as engineer-manager of the Warm Springs irrigation projects at Vale, Ore., and will open an office for private practice in Portland, Ore.

FRANK A. MARSTON has become a junior partner in the firm of Metcalf & Eddy, consulting engineers of Boston, with which firm he has been connected since 1907.

H. R. ABBOTT, recently supervising engineer of the sewage disposal and additional water supply at Fort Sheridan general hospital No. 28, announces the formation of the H. R. Abbott Company, engineers and contractors, Chamber of Commerce Building, Chicago. The company will specialize in water supply, water purification and sewage disposal contracts. Mr. Abbott was two years in government service, the first year being with the Sanitary Section of the Construction Division in charge of the design of sewers and sewage disposal of the southern camps, with headquarters in Washington. Previous to that he was assistant engineer of the Sanitary District of Chicago for eight years, and for the eight years previous he was with the Chicago elevated railroads. He had charge of the construction of the Metropolitan extensions to Douglas Park and Garfield Park.

DR. WILLIAM H. WALKER, for many years head of the Research Library of Applied Chemistry at the Massachusetts Institute of Technology, has been named as head of the institute's new division of industrial cooperation and research. Dr. Walker was connected with the institute for

twenty-five years before the war, and during the war served as colonel in the Chemical Warfare Service. He was in command of Edgewood Arsenal, Maryland, and was awarded the Distinguished Service Medal.

MARVIN CHASE, state hydraulic engineer, State of Washington, announces that he has not resigned that office, as noted in ENGINEERING NEWS-RECORD of Dec. 25. A recent news item stated that Mr. Chase had resigned the chairmanship of the State Reclamation Board.

M. O. O'BRIEN, C. O. O'BRIEN, S. K. SPELLACY, J. S. TAIT and JOHN G. TAIT have incorporated as the Ohio Willite Road Construction Co., with headquarters in Lima, Ohio.

PIERRE CHARTON of the firm of Beique & Charton, consulting engineers of Montreal, Can., who served as an officer in the French army during the World War, has just received the Croix de Guerre. His citation, contained in French General Orders, states that the award is made for his "energy, *sang froid*, and devotion to duty under fire."

OBITUARY

HENRY WALKER HARTWELL, architect and structural engineer of Boston, died at his home in Waltham, Mass., Dec. 31, 1919, after a prolonged illness. Mr. Hartwell for more than a score of years was identified with the architectural firm of Hartwell & Richardson which built many notable buildings in New England. Among the best-known are the old *Youths' Companion* Building in Boston, the Carney Building, Tremont St., Boston; the First Church, Plymouth, Mass.; Christ Church, Andover, Mass.; high schools at Springfield and Cambridge, Mass., as well as many other public buildings.

SOLOMON D. ROGERS, prominent construction engineer and inventor of Sacramento, Cal., died at his home there Dec. 20, at the age of sixty-three years. At the time of his death he was chief engineer of the Commercial Car Construction Co., and engaged in supervising the construction of a large car-building plant in which the company intends to manufacture a motor car invented by him.

T. A. BARKER, former Cleveland building contractor, who directed the erection of the Soldiers' and Sailors' monument and other public structures in Cleveland, died in his home in Phoenix, Ariz., Dec. 27, at the age of seventy-five.

As a young man Mr. Barker came to this country from England, settled in Cleveland, Ohio, and took up construction work. He became a specialist in exterior decorative work, his first notable performance being the erection of the Soldiers' and Sailors' monument. Later he was identified with the construction of the Federal Building, the First National Bank Building, and the courthouse in Cleveland. Upon the completion of the last-named building, five years ago, Mr. Barker retired, and with his family moved to Phoenix, Ariz.

MAJOR HAROLD S. HETRICK, Corps of Engineers, U. S. Army, was shot and fatally wounded by an unknown assailant in his home in New Orleans Jan. 2. Major Hetrick graduated from West Point in 1906. During the Great War he served as a temporary colonel of engineers. Latterly he had been in charge of the Corps of Engineer work between New Orleans and Vicksburg in the Mississippi District.

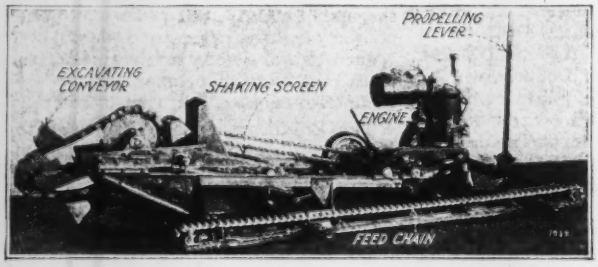
JOHN HANCOCK SWARTZ, inventor of the Eagle Water Meter, the dovetail box machine and of civil war grenades, died in Brooklyn Dec. 30 at the age of eighty-four.

JOHN GILLIES, eighty-five years old, builder of most of the big steamship piers on the North River in Manhattan, and of piers, bridges and drydocks at the Navy Yard in Brooklyn, died in New York City Dec. 31. Mr. Gillies was born in Nova Scotia. He entered the contracting business in New York City when a young man and continued it until his retirement about ten years ago. Thirty years ago he was the largest stock builder in New York steel.

New Machine Cleans Track Ballast

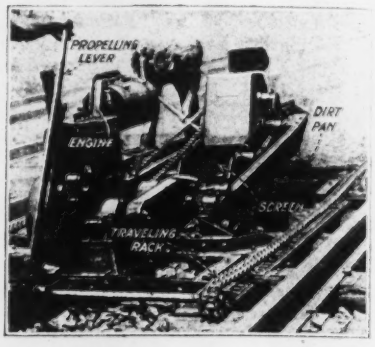
A machine for cleaning old stone ballast in the track, which is being operated on the Pennsylvania R.R., indicates the possibility of an important saving in time, money and labor as compared with the more usual method of cleaning by a gang of men with picks and forks. Cinders and dirt accumulating in the ballast gradually clog it until proper drainage is prevented, so that periodical cleaning is required.

As the machine travels longitudinally along the space between the tracks, it



BALLAST-CLEANING MACHINE HAS BUCKET EXCAVATOR

digs, cleans and replaces the ballast in this space, while it will also clean ballast shoveled into it from between the ties of the tracks on either side. Its size (5 ft. wide by 8 ft. long) was limited by the necessity of keeping it clear of passing trains. The frame travels on two endless-chain tracks which ride on the ends of the ties and pass over pinions on two cross-shafts at the front



PORTABLE MACHINE CLEANING BALLAST ON PENNSYLVANIA LINES

and rear of the machine. These tracks are driven by a man operating a ratchet lever on the rear shaft, and it is stated that with one hand he can feed the machine forward while it is working in 18 in. of ballast. However, the machine can be made self-propelling, so as to eliminate one man of the present gang working with it.

A chain- and bucket-excavator and conveyor at the head of the machine digs to a depth of 18 in. below the ties and in a path about 12 in. wide. This width is limited by the clearance between trains at the height of the buckets in the upper or dumping position when passing over the head wheel. The ladder frame which carries the excavator is pivoted so that it can be raised when the machine is not in operation or is being shifted to or from its work. From the buckets the ballast is delivered to a flat, inclined shaking screen which is operated at high speed. The stone passing off the screen drops into place behind the machine, a V-shaped crossbar spreading it so as to fill the entire space between the ends of the ties. The dirt passes through the screen and is deposited on a flat pan or plate, from which it is removed with a shovel and piled at the outside of the roadbed for subsequent removal.

Five men constitute the working gang. Two of these work ahead of the machine, loosening the ballast around the ends of the ties and feeding it to the buckets with forks. A travel of 25 to 30 ft. is made in 35 to 45 min. It is stated that this distance is an average day's work for one man cleaning ballast with a fork, so that in an 8-hour day the machine with 5 men would do the work of a gang of 8 or 12 men and at 50% of the cost. Its service is too limited yet to permit of definite records of the performance.

The design of this machine was worked out by H. D. Pratt, engineer for the Link Belt Co., Philadelphia, at the request of the engineers of the Pennsylvania Railroad.